PRODUCTION EXHIBITION AND CONFERENCE, 1954

THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

THE INSTITUTION OF

PRODUCTION ENGINEERS JOURNAL

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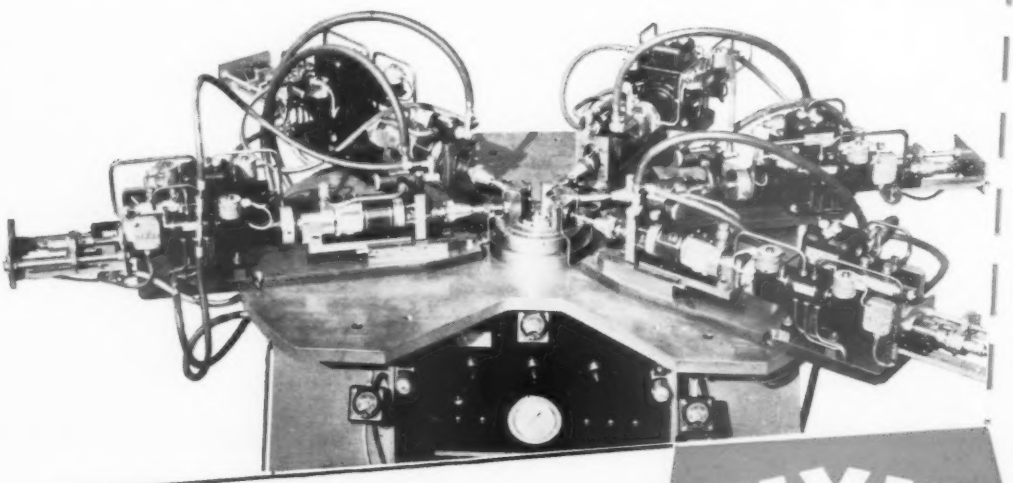

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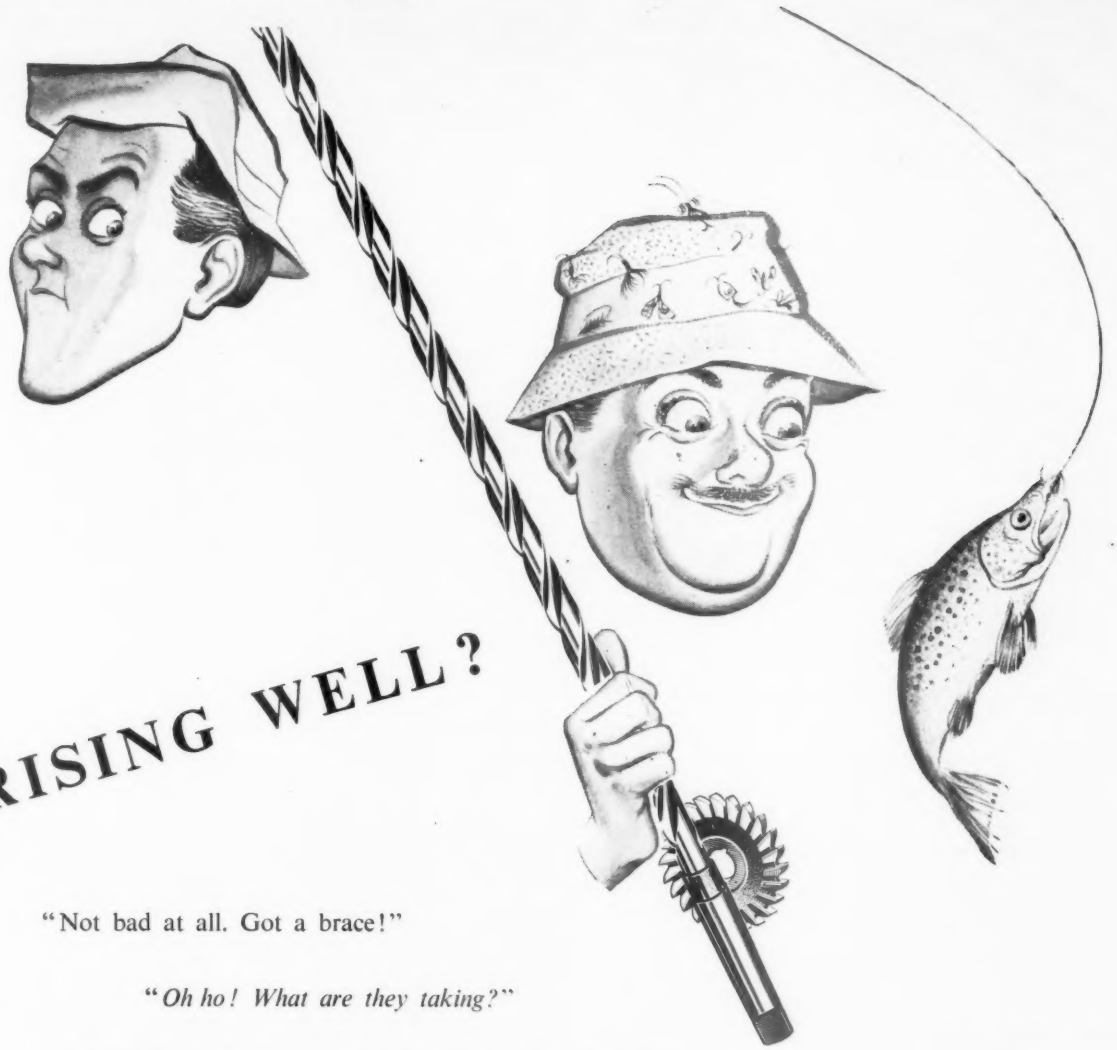

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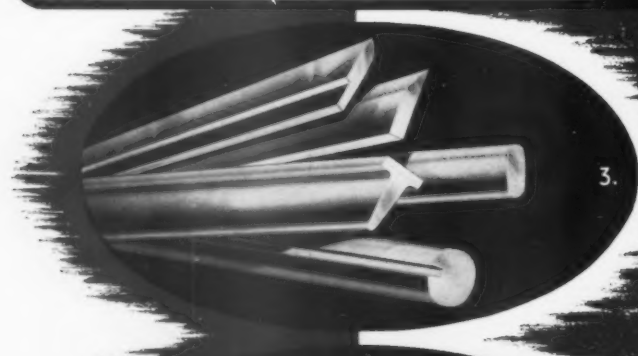

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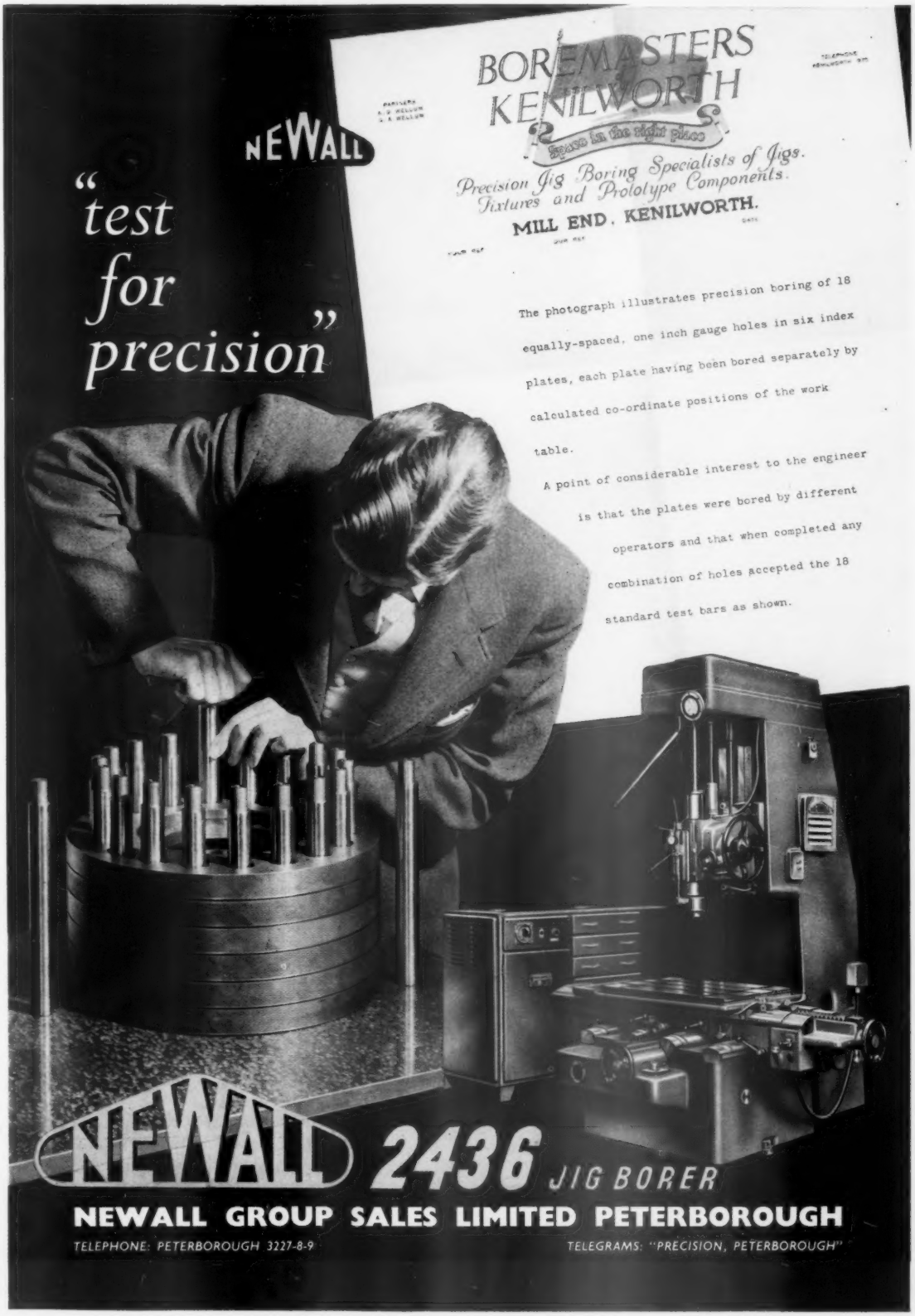
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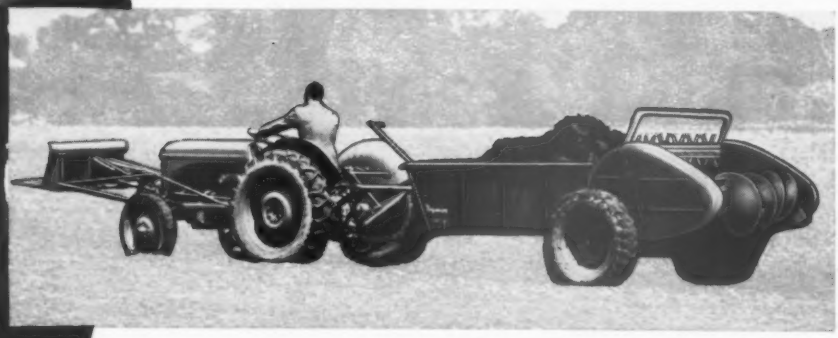

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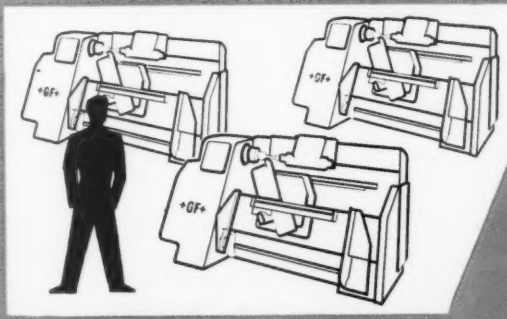

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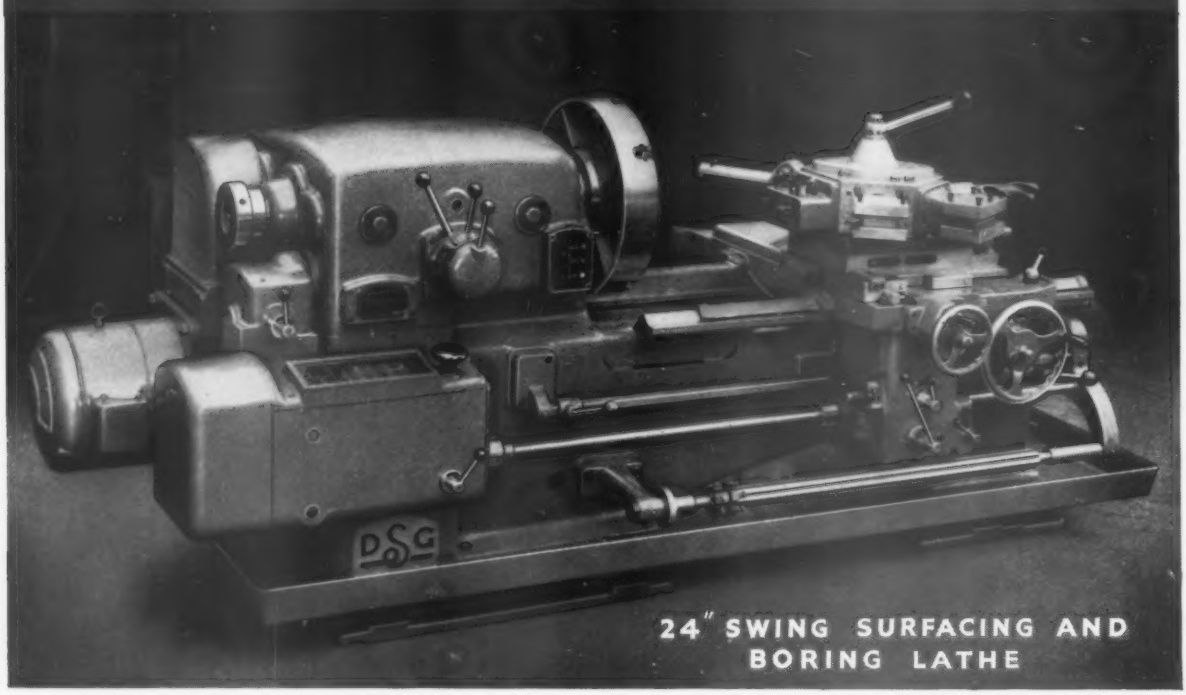

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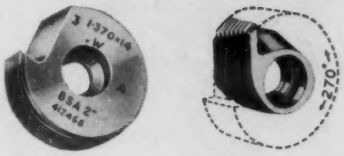

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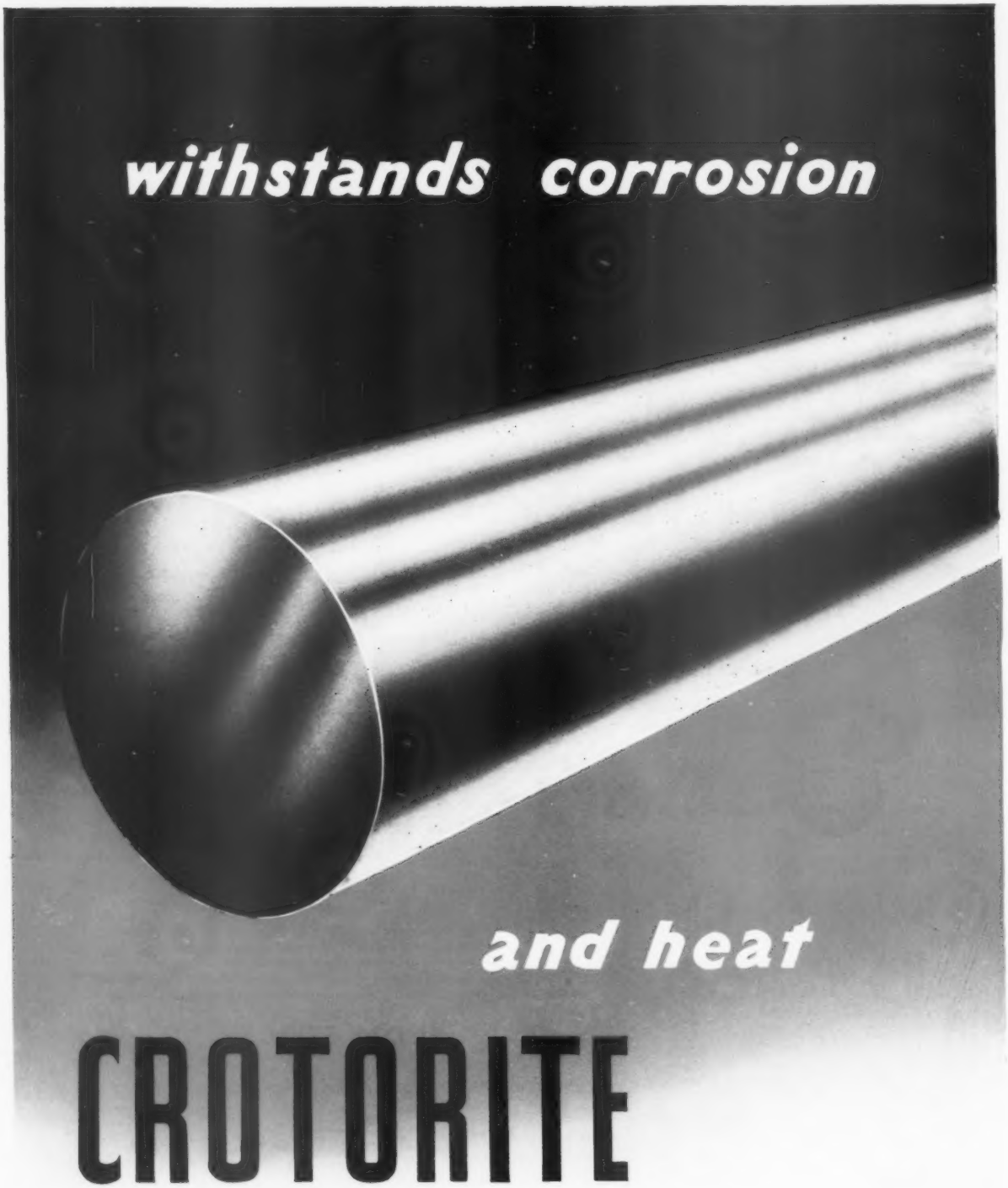

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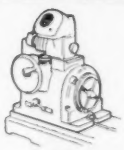

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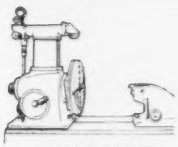

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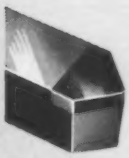

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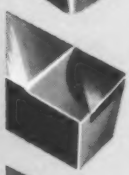

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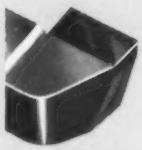

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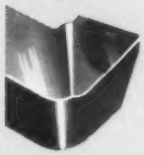

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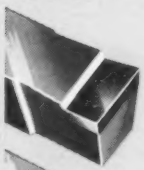

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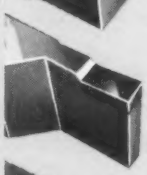

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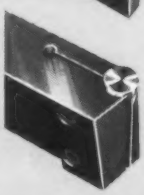

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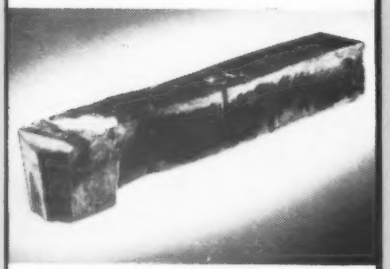

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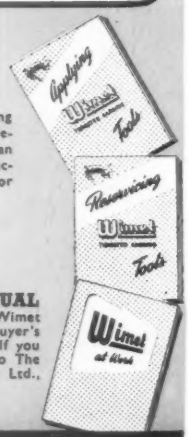

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The Institution of Production Engineers Journal
VOL. 33 NO. 7 JULY, 1954

The Production Exhibition and Conference

A Message from
The President of the Board of Trade,
The Rt. Hon. PETER THORNEYCROFT, M.P.

THE Production Exhibition and Conference being held in London this month reflect great credit on the Institution of Production Engineers. These important events, which the Institution has sponsored, have deservedly attracted wide attention at home and abroad and I look upon them as a fine example of a professional body performing a valuable service, both for its own members and for the public at large.

I welcome the Exhibition as the first attempt in this country to demonstrate on a national scale and in visual form the importance of productivity. It provides a unique opportunity for the exchange of technical knowledge and experience and it offers a series of vivid examples of efficiency in several spheres, which can hardly fail to impress many of the thousands of the visitors to it, who will come from all sides and all sections of our industry. If each visitor returns to his work with a desire to adopt in his own factory only one of the many good ideas shown at the Exhibition, then a valuable purpose will have been served. But I am sure the Exhibition will achieve a great deal more than that and I hope it may become a regular feature of our national life.

There is no question but that increasing productivity is of great importance to our economy. For that reason, the Papers by eminent authorities, to be read at the Conference, dealing with many aspects of productivity, deserve to reach a larger audience than will be there to hear them read. I am glad, therefore, that they are to be published in the Institution's Journal.

One of the useful purposes served by the work of the Conference is to show the relationship between production engineering and industrial, economic, social and educational problems as a whole. In this way the specialist is able to see his work in perspective and appreciate the connection between it and the work of other people, employing different means to the same end. This applies as much, for example, to the designer or the research worker as to the production engineer. All are members of the production team, concerned with their factory's product from start to finish, and if a barrier exists between them they, as well as their industry, will be the losers. It is an important function of any professional association to break down such barriers where they exist, and I am glad to see how well the

Institution of Production Engineers is working in this field. The breadth and variety of the Conference programme reinforces this idea that, while it may be convenient for purposes of discussion to separate the various factors in productivity, a proper understanding of its problems and success in solving them will not be achieved until everyone concerned is able to see how closely all these factors and all these techniques are related.

The production engineer is a vital link in the chain for he is concerned with most of the factors in productivity; that, after all, is why he is there. There is a popular, and perhaps understandable, belief that the principles of production engineering apply only to the engineering or metal-working industries. One of the services done by the Institution, especially in sponsoring such an Exhibition as this, is to correct such mistakes on the part of industry and public alike and to extend its influence more widely. The more widespread this understanding of the need for greater efficiency becomes, the greater will be the service of the Institution to the national interest.

The Production Exhibition and Conference

Olympia, London

7th/14th July, 1954

The Papers presented to the Production Conference are being published in this and subsequent issues of the Journal. This issue contains the following :-

SESSION III, 8th JULY

" Practical Applications of Production Engineering Research " by Dr. D. F. Galloway, B.Sc., M.I.Mech.E., M.I.Prod.E., Director of Research, Production Engineering Research Association of Great Britain.

" Production Engineering Research and the Information Services at Work in the Factory " by W. P. Kirkwood, B.Sc., M.I.Mech.E., M.I.Prod.E., Works Manager, Albion Motors, Ltd.

SESSION VI, 12th JULY

" The Trade Union Attitude to Research and Productive Efficiency " by James Crawford, F.B.S.I., Member of the General Council, Trades Union Congress; General President, National Union of Boot and Shoe Operatives.

SESSION VII, 12th JULY

" Standardisation in the Process Industries " by E. W. Greensmith, A.C.G.I., B.Sc., M.I.Mech.E., Engineering Services Department, Imperial Chemical Industries, Ltd.

SESSION X, 14th JULY

" Human Factors in Technological Change " by Professor C. A. Mace, M.A., D.Litt., F.B.Ps.S., Professor of Psychology, Birkbeck College.

PRACTICAL APPLICATIONS OF PRODUCTION ENGINEERING RESEARCH

by Dr. D. F. GALLOWAY,

Wh.Sch., B.Sc.(Hons.), M.I.Mech.E., M.I.Prod.E., M.I.I.A., A.M.I.E.E., M.Inst.Pet.

Dr. Galloway received his technical education at Birmingham Central Technical College and Cambridge University. He served his apprenticeship with the Birmingham Small Arms Company, Limited, and subsequently specialised in the design and layout of mass production plant.

He was awarded a Whitworth Scholarship and Whitworth Senior Scholarship, and obtained a B.Sc.(Eng.) (Lond.) with first-class honours. Later he received the degree of Ph.D. for research on machining of light alloys. He was appointed Assistant Director and later Director of the Research Department of the Institution of Production Engineers and in 1946, when the Production Engineering Research Association of Great Britain was formed, Dr. Galloway was appointed Director of Research.

He is a Member of Council of the Institution of Mechanical Engineers and a founder member of the International Institution for Production Engineering Research.

Dr. D. F. Galloway

THE ultimate objective of production engineering research is the economic gain arising from the application of the research results. In order to get the maximum economic gains for the minimum expenditure on research, the British engineering industry in 1946 set up the Production Engineering Research Association of Great Britain by acquiring the equipment and a nucleus of staff from the Institution of Production Engineers' Research Department which had been engaged on similar research since 1939. The main objective of PERA is to improve production techniques by research in centralised laboratories and workshops, and by gathering and evaluating available information on production developments throughout the world. PERA has also undertaken the responsibility of conveying these improvements in production techniques to the principal production personnel in its member-firms by means of practical demonstrations and other educational means.

Some indication of the present scale of these activities and of the research equipment and methods which have been developed in the last few years, is given in this Paper. It is not practicable to refer to all the researches which have been completed or are in progress, and representative examples have therefore been selected to illustrate the methods and equipment.

Production engineering research can be defined as investigation to discover the basic data and laws relating to the planning, control and execution of processes by which material is given a predetermined form with the aid of machines, tools and labour. The specific objective of this research is to increase the efficiency with which processes such as thread rolling, impact extrusion, die casting, finishing, assembly, plastic moulding, milling, drilling, turning, pressing, etc., are carried out; to raise the efficiency of auxiliary production activities; and to improve such functions as production control, rate-fixing, planning, etc.

An Example of Methods and Equipment

Since the ultimate objective of this type of research is the economic gain accruing from application of the research results, the technical criteria which indicate

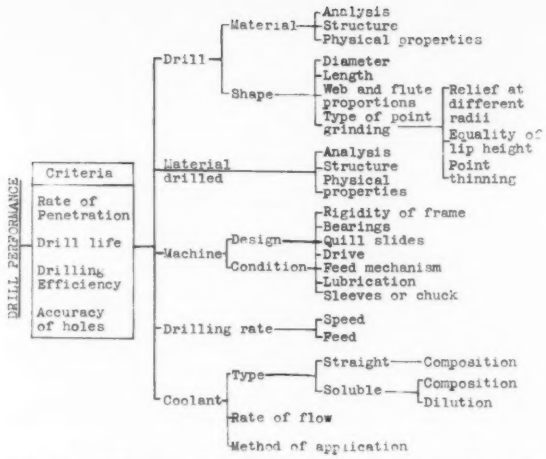


Fig. 1. Objectives in drilling and factors affecting drill performance.

the overall economy of the operation must be clearly identified. In a drilling operation, for example, these technical criteria are :

1. Rate of penetration, for example, depth of hole drilled per minute.
2. Drill life, usually expressed as depth drilled between grinds; it is also necessary to consider total drill life, that is, total depth before the drill is discarded. (These two criteria are not in the same ratio for different drills and drilling conditions).
3. Drilling efficiency, expressed as the volume of metal removed per horsepower-minute or as power required for a given rate of drilling.
4. Accuracy of holes, that is, diameter, straightness, etc.

When the research worker has determined these criteria the next step is to identify the factors on which they depend. Factors affecting drill performance are shown in Fig. 1. When these have been identified three general methods of research can be considered :

1. To take a very large number of tests under practical conditions and attempt to separate the effects of the various factors by statistical or other means. The cost of such a procedure, both in terms of material and time, is usually prohibitive.
2. To control all factors except one, which is intentionally varied, and observe the effect of that factor on the criteria.
3. A combination of Methods Nos. 1 and 2.

Method No. 3 is generally used. It is usual to design the research so that as many factors as possible are brought under the maximum degree of control, and the technique used is essentially the third method approximated as closely as possible to the second method. The task of controlling or measuring the variations in the numerous factors is very difficult, but also very important to the success of this approach to production problems.

A range of special equipment has been developed by PERA for determining the effects of various factors on drill performance. In addition, standard equipment and methods are used for testing the physical properties of the drill and workpiece material, composition of the workpiece materials, etc.

The need for physical tests is apparent from observations of properties such as hardness. In nominally similar drills hardness near the point varied from 820 to 970 D.P.H. and the variation of hardness along what would generally be regarded as the working length of the drill was sometimes as high as 950 D.P.H. near the point, to 600 D.P.H. about two-thirds back along the fluted length. Such variations in hardness along the drill have to be taken into account in the test procedure.

Special grinding and inspection equipment has been developed to ensure the uniformity of such factors as drill point thinning, relief angle and relative lip height of all drills used in investigations. Fig. 2 illustrates inspection equipment for exploring the points of large drills, but more sensitive instruments are necessary for small drills, and a small optical drill point tester embodying a microscope attachment is shown in Fig. 3. A drill point inspection gauge for workshop use is shown in Fig. 4.

Recent research has shown that adoption of a smaller relief angle than is generally used in industry, and closer control of relative lip height, reduce drill breakage, increase drill life, permit higher feed rates and improve the accuracy and finish of holes produced. Due to unsatisfactory point grinding either in the user's workshop or the maker's factory, large differences occur in the relative lip height and relief angle of drills used in production. Inspection of a number of nominally similar $\frac{5}{8}$ in. diameter drills showed that relief angle at the periphery varied from

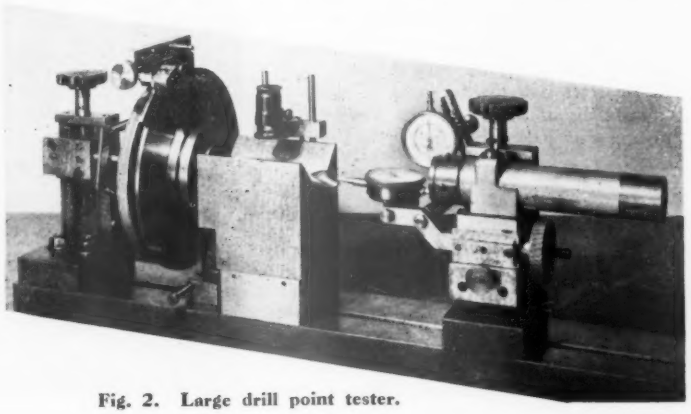
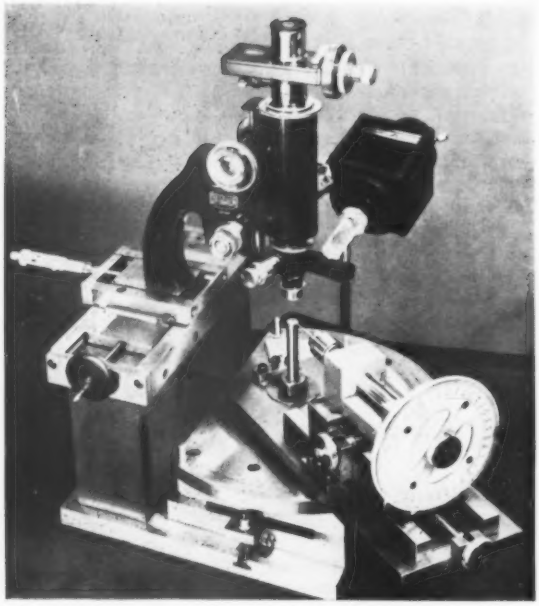


Fig. 2. Large drill point tester.



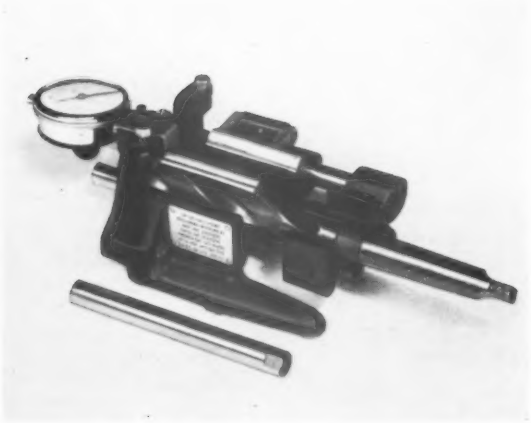


Fig. 3 *(top left)*. **Optical drill point tester for small drills.**

Fig. 4 *(above)*. **Drill point inspection gauge for workshop use.**

Fig. 5 *(below)*. **Portal frame drilling machine used for drilling investigations.**

7° to over 20°, and relative lip height often exceeded 0.010 in., whereas it should not exceed about 0.002 in.

Drilling tests are conducted on special machines, such as that shown in Fig. 5, designed to eliminate variations resulting from the condition of the machine, construction of frame, etc., and to control the effects of inevitable machine deflections and vibrations. Another special machine built for testing small drills down to about 0.0135 in. diameter is shown in Fig. 6. This machine has been designed for a spindle speed of 90,000 r.p.m.

Various dynamometers have been developed for measuring the torque and thrust of drills in use. A typical dynamometer can be seen below the drill spindle in Fig. 5, the instrument box for the dynamometer being shown on the right hand side of the machine. Another type of dynamometer used for drilling tests with drills down to a few thousandths of an inch in diameter is shown being calibrated in Fig. 7.

Effect of Factors in Drilling

The relationships between the criteria of performance and many of the factors listed in Fig. 1 have been investigated by PERA, and some parts of the researches into the effects of drill shape, and of cutting fluids, have been selected to illustrate the results of such researches.

Effect of Drill Shape and Proportions

The geometric features of a drill may have a marked effect on drill life, rate of penetration, power consumption, and hole accuracy and surface finish, although these effects vary substantially under different conditions. Considerable variations often occur in the flute proportions of nominally similar drills, and these differences can significantly affect drill performance.

Large errors in drill symmetry may occur through unequal fluting, and this may impair drill performance. Errors of 1° or 2° in lip spacing, for example, can adversely affect drill point shape, particularly if, as is usual, the drill is aligned by one lip for grinding.

Relative lip height is one of the most important and most common sources of error in drill grinding, and excessive differences in lip height constitute a major cause of inefficiency in drilling. This is confirmed by the results, which are shown in Fig. 8, of some tests on the effect of variations in lip height on drill life. In production drilling operations on a steel bracket, drill life was increased from 70 holes per grind to 200 holes by reducing the lip height of $\frac{5}{8}$ in. diameter drills from 0.010 in. to 0.001 in.

The function of the relief angle is to provide clearance behind the cutting edge so that the drill may cut freely without rubbing, but the relief angle also affects drill life. Considerable differences in drill life have been observed when relief angles have been varied over a comparatively small range in certain drilling operations. Production drilling costs can usually be reduced by decreasing the values of relief angle commonly used in industry.

A representative example of the combined economic effects of a reduction in relative lip height and relief angle concerns the drilling of $\frac{5}{8}$ in. diameter holes in a steel forging. By reducing relative lip height from 0.010 in. to 0.001 in., and relief angle from 12° to 5°, the cost of production drilling operations was reduced by more than 16%. This result was achieved by modifying only two of the factors shown in Fig. 1, and in practice, greater economies can be achieved by maintaining adequate control over the other factors which have been shown by research to have a significant effect on the speed, economy, and quality of drilling.

Effects of Cutting Fluids

Some of the functions of a cutting fluid used in drilling operations are to:

1. Keep the drill cool.
2. Lubricate the drill lands in the walls of the hole.
3. Lubricate the flutes of the drill to facilitate the passage of swarf.
4. Remove the swarf from the cutting zone.

These requirements are met in varying degrees by different fluids and selection therefore usually involves a compromise. The cooling function is usually of great significance in drilling operations.

Characteristic drill life graphs obtained with three different neat oils are shown in Fig. 9, and the effects

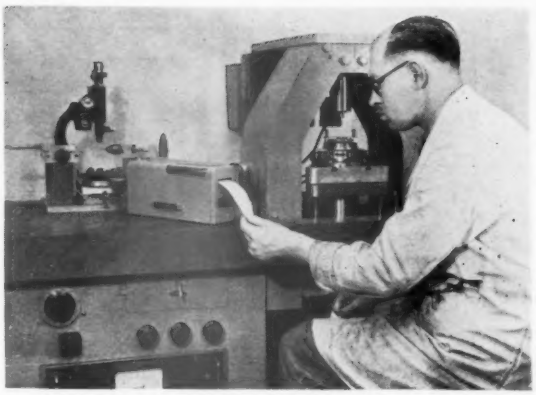
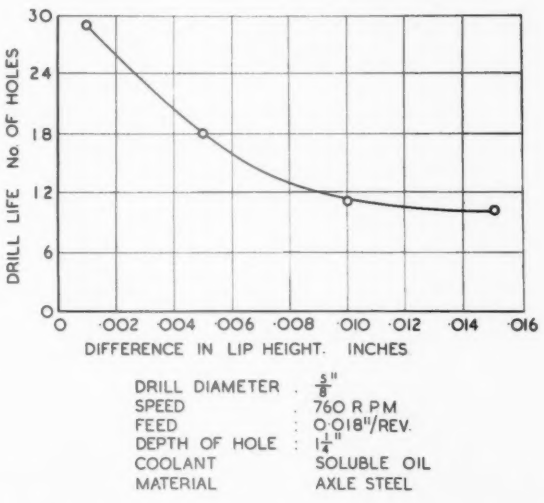


Fig. 6. Special machine built for testing small drills down to about 0.0135″ dia.

Fig. 7. Small drill dynamometer being calibrated.



EFFECT OF DIFFERENCE IN LIP HEIGHT ON DRILL LIFE.

Fig. 8. Effect of relative lip height on drill life.

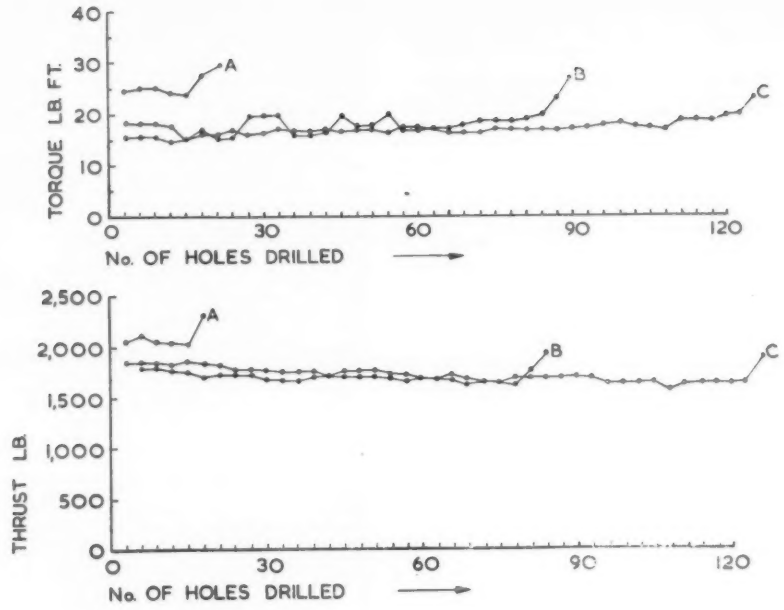


Fig. 9. Characteristic drill life graphs obtained with three different neat oils.

of different neat and soluble oils on drill life, torque and thrust are shown in Fig. 10. (The increase in torque and thrust as drill life decreases when using the neat oils specified in Fig. 10 is not common to all neat oils, and does not occur with soluble oils. Torque and thrust tests cannot therefore be used alone for estimating the effects of cutting fluids on drill life). A cutting fluid reduces torque and thrust compared with dry cutting, and hence reduces the net cutting power, but there are considerable differences in the reductions with different holes. These differences tend to be accentuated as the depth of hole increases.

The performance of eleven commercial soluble oils has recently been determined when drilling three steels, and the variations in drill life with the different oils and materials are summarised in Fig. 11. The grouping in the bar charts is based on statistical

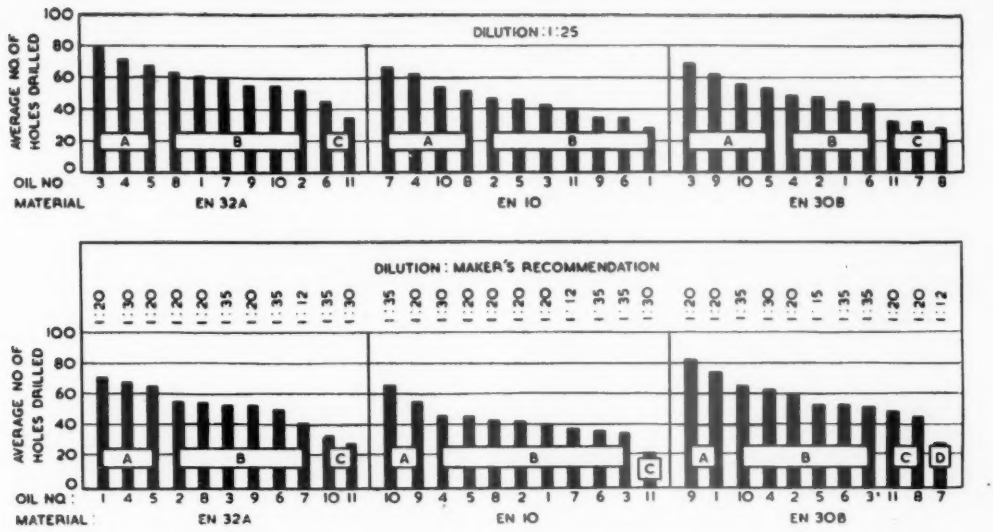
(a)

Cutting Fluid	Torque lb. ft.	Thrust lb.	No. of holes drilled
Neat Oil I	18	1,650	109
Neat Oil II	20	1,600	62
Neat Oil III... ...	23	1,750	48
Neat Oil IV	28.5	2,200	29
Neat Oil V	30	2,250	20
Dry	32	2,450	2

(b)

Cutting Fluid	Dilution	Torque lb. ft.	Thrust lb.	No. of holes drilled
Soluble Oil II ...	1 : 15	19	2,050	132
Soluble Oil I ...	1 : 15	22	2,000	14
Soluble Oil II ...	1 : 25	22	2,050	122
Soluble Oil I ...	1 : 25	23.5	2,000	3

Fig. 10. Effects of various cutting fluids on torque, thrust, and drill life when drilling $\frac{3}{8}$ in. diameter holes in axle steel.



OIL PERFORMANCE GROUPING WHEN DRILLING THREE MATERIALS

Fig. 11. Grouping of eleven commercial soluble oils according to performance when drilling three steels.

analysis of the results. An improvement in performance resulting from the use of a cutting fluid can usually be translated into an increase in drill life for a given drilling rate, or an increased drilling rate for the same life.

Typical effects of cutting fluids on hole accuracy and surface finish when drilling axle steel are shown by the research results given in Fig. 12 for two neat oils and one soluble oil. Although there were differences in the results obtained with different neat oils, it could be concluded that the neat oils were superior to the soluble oils.

In addition to tests of the performance of cutting fluids in different machining operations, it is necessary to make observations of fuming, corrosive properties, etc., before a complete evaluation can be made of the fluids for production operations.

Important machine tool surfaces, workpieces, and tools, may be stained or pitted as a result of corrosion by cutting fluids. It has been found in tests carried out by PERA that various soluble oil emulsions differ considerably in their corrosive action, and thus careful selection of soluble cutting oils will assist in reducing corrosion problems. Examples of the differences in the corrosive effects of different soluble cutting oils are shown in Fig. 13.

Turning Research

In drilling operations, the cutting tool usually takes a roughing cut only, but many other machining operations involve roughing and finishing cuts, and it is desirable to separate practical tests into two sections having different criteria for assessing performance, as rough machining and finishing operations have very different objectives. The criteria of performance in rough and finish turning are shown in Fig. 14, together with the main factors affecting performance.

Speed r.p.m.	Feed in./rev.	Cutting Fluid	Average oversize, in.	Average surface finish, mu. in.
406	0.005	Neat Oil A	.0077	60
406	0.005	Neat Oil C	.0099	90
406	0.005	Neat Oil I	.0076	130
406	0.005	Dry	.0105	Could not be measured

Fig. 12. Effects of cutting fluids on hole accuracy and surface finish when drilling $\frac{3}{8}$ in. diameter holes in axle steel.

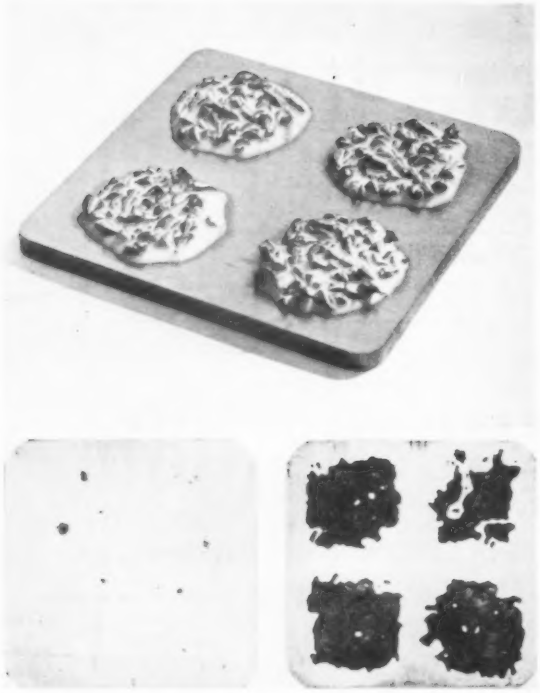


Fig. 13. Corrosion testplate for soluble oils, and examples of corrosive effects of different soluble cutting oils.

In rough turning operations, maximum rate of stock removal and minimum power consumption are factors of major importance upon which consideration of economic tool life must be based. In finishing operations, surface finish and dimensional accuracy are of most importance, so that even slight tool wear must be taken into consideration, and the economic tool life must be based upon these factors, rather than upon stock removal or power consumption.

Fig. 15. PERA tool radius grinding attachment.

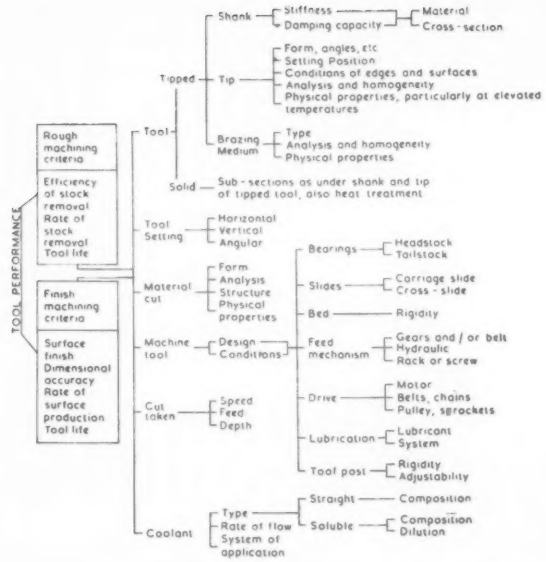
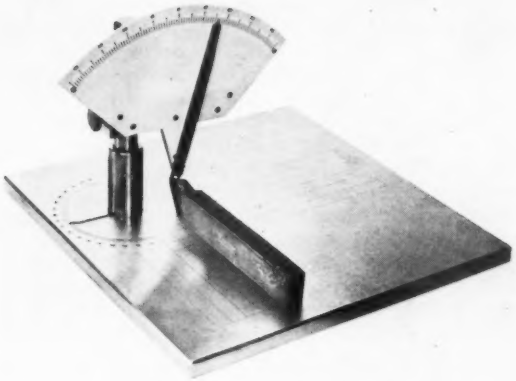


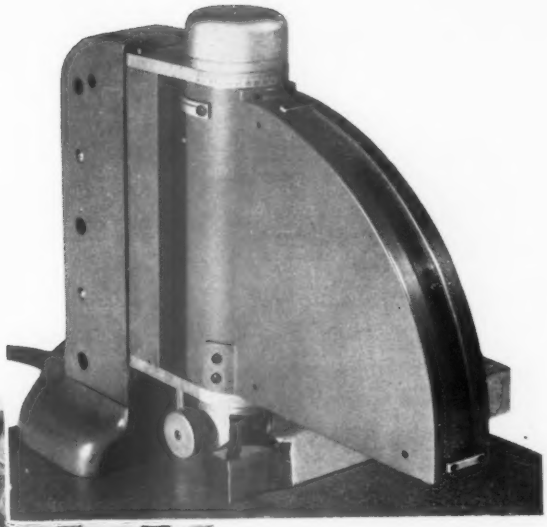
Fig. 14. Objectives in rough and finish turning and factors affecting tool performance.

Rate of stock removal and efficiency of stock removal are unimportant in finishing operations, since the depth of the finishing cut can easily be reduced to a minimum by adjusting the cut in pre-finishing operation, and moreover the power required to run the machine during the finishing operation is not much greater than the power *to run the machine idle* at the same speed.

For tests to provide reliable comparisons, much closer control than is possible in a production workshop must be maintained over such factors as tools, materials, lubricants, machines, etc. The tool radius grinding attachment shown in use in Fig. 15 incorporates a microscope which enables the tool nose radius to be accurately ground and blended into the tool flanks, and a protractor fitted to the front of the instrument allows the side cutting angle and plan relief angle to be ground at the same machine setting. Photomicrographs or enlarged silhouettes can also be used for checking nose radii, although it is often unnecessary to make actual photographs, but merely to focus the image on a ground glass screen and check the outline with a transparent radius gauge.

A special tool angle protractor developed for inspecting single-point tools is shown in Fig. 16. It has horizontal and vertical protractor scales, the vertical scale and its pointer being on a spring-loaded sleeve for case of vertical adjustment. Rake and relief angles are measured by bringing small contact points against





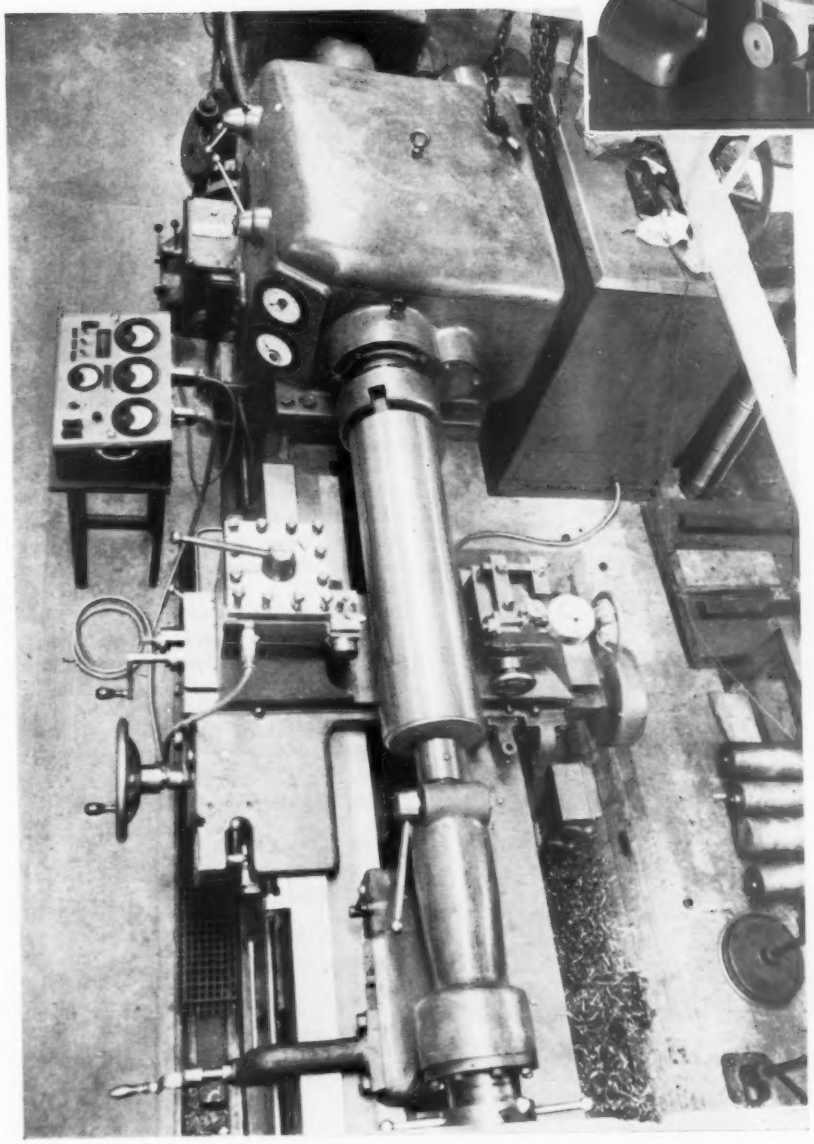


Fig. 16 *(top left)*. **Special tool angle protractor for inspecting single point tools.**

Fig. 17 *(above)*. **Tool angle protractor for workshop use.**

Fig. 18 *(left)*. **Heavy-duty tool testing lathe.**

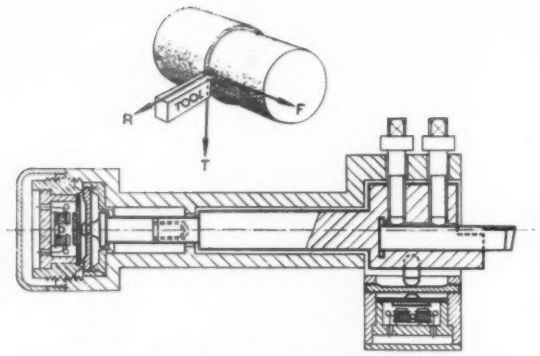


Fig. 19. PERA single-point tool dynamometer.

the tool face and flank respectively, the measured angle being indicated on the vertical protractor scale. A workshop instrument has been developed from the original design and this is shown in Fig. 17.

Practical turning tests are often carried out on specially designed lathes such as that shown in Fig. 18. The machine is of robust construction and the tool post is designed to hold cutting tools or a tool force dynamometer. The dynamometer is connected to an instrument box having three main dials which record the three components of the cutting force. A photograph and a cross-section of a representative single-point tool dynamometer is shown in Fig. 19. The three directions in which the cutting forces are measured are also shown.

Fig. 20. Research in progress to determine the performance of medium-sized taps.

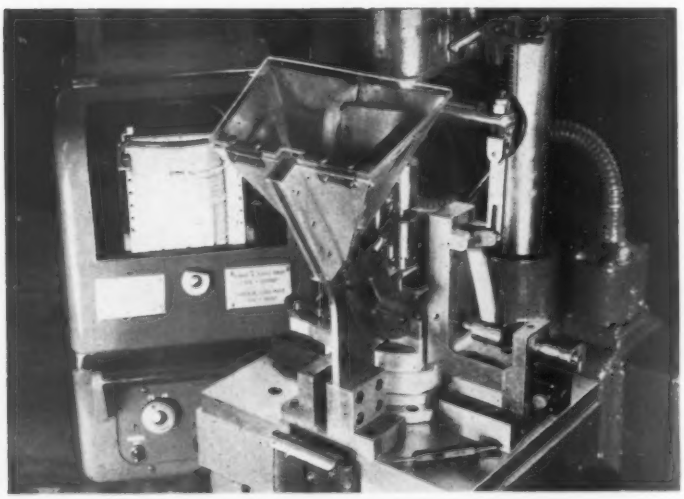


Fig. 21. Automatic tapping fixture and recorder for tests with small taps.

Research into other Machining Processes

Research into milling, tapping, grinding, broaching, etc., involves control of factors as numerous as those encountered in drilling and turning. The extent of research necessary to secure authoritative data for application in workshops may be judged from the fact that in a tapping investigation, for example, 10,000 tap measurements have been made, in addition to the tapping of approximately 300,000 holes. Automatic equipment which has been made to expedite this work and to ensure that the tests are closely related to factory conditions is illustrated in Figs. 20 and 21. Fig. 20 shows tests in progress to determine the performance of medium-sized taps. A tapping rate of up to 1,000 per hour is maintained. Fig. 21 shows a fully automatic tapping fixture and recorder for tests with small taps. Nut blanks are fed to the tapping dynamometer at a rate of 2,000 per hour, and tapping forces are automatically recorded.

Research has confirmed that variations in tap design have a considerable effect on tap performance, and Fig. 22 is included as an example of the large differences which have been observed in the lives of $\frac{1}{2}$ in. B.S.F. taps. Considerable differences have been observed in the flute areas of nominally similar taps, and the cross-sectional areas of the flutes of the taps shown in Fig. 23, were 42, 67, and 54 per cent. of the full cross-sectional area.

Machine Tool Utilisation

General investigations of several types of machine tool, such as lathes, drilling machines, grinding machines, milling machines, have now been

Tap	Number of holes tapped
A	3,000 plus
B	2,250
C	318
D	300
E	151
F	50

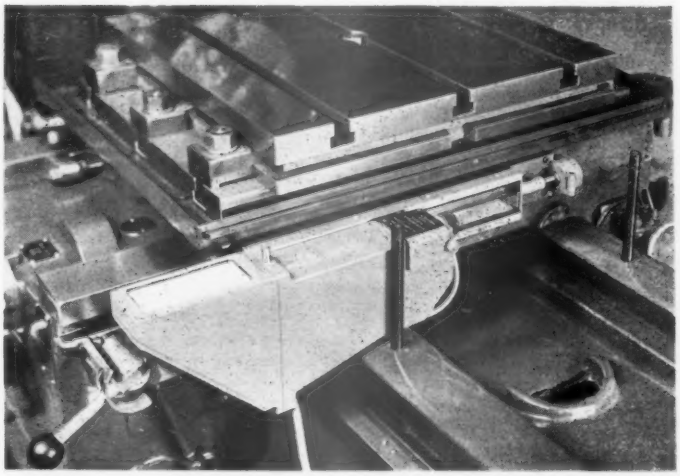
Fig. 22. Differences in the lives of ½ in. B.S.F. taps.

Data: Tap: H.S.S., ½ in. B.S.F., Ground Thread
Material Tapped: Steel En3B.
Cutting Fluid: Sulphurised Neat Oil.

Fig. 23. Cross-sections of three nominally similar taps. The flute areas of the taps, expressed as a percentage of the cross sectional area of the major diameter of the thread were 42%, 67% and 54%, respectively.

completed or are nearing completion at PERA. These researches are designed to give the maximum information regarding the efficient utilisation of the main groups of machine tools. The researches include full performance tests for roughing and finishing operations under various conditions. In addition to the normal accuracy tests of the alignment of spindles, guides, etc., special tests are sometimes made such as that referred to in Fig. 24, which gives the results of observations of the errors which occur in setting the table of a boring machine when using first a standard vernier scale, and then an optical vernier attachment. This illustration also shows that the optical vernier attachment reduced the error in any one setting of the table to ± 0.0002 in. against ± 0.0009 in. with a standard vernier. The optical vernier could also be set twice as quickly as the standard vernier.

One of the essential requirements of efficient machine tool utilisation is knowledge of the influence of cutting forces on the deflection or distortion of the workpiece and machine elements. Because of the elasticity of such machine elements as spindles, bearings, arms, columns, etc., even relatively small loads may affect the functioning of the machine or accuracy of the work produced. The effect of these deflections on the accuracy and quality of work produced is often important, but of even greater importance in most instances is the effect of the machine flexure on the performance of the cutting tool, that is, limitations on feed,



Measurement	Optical Vernier	Conventional Vernier
Accuracy of repeat settings ...	±0.0002″	±0.0009″
Maximum error on two spaced settings	0.0005″	0.0013″
Setting time	50%	100%

Fig. 24. Comparison of optical and conventional verniers.

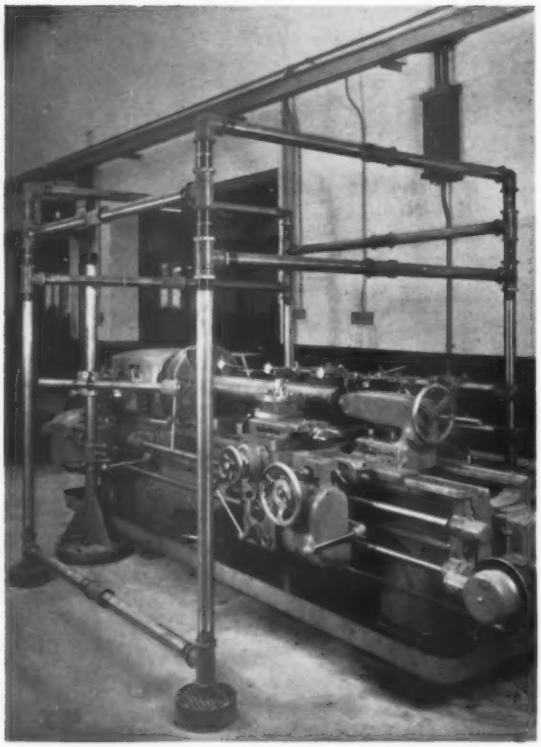


Fig. 25. Set-up for deflection tests on centre-lathe.

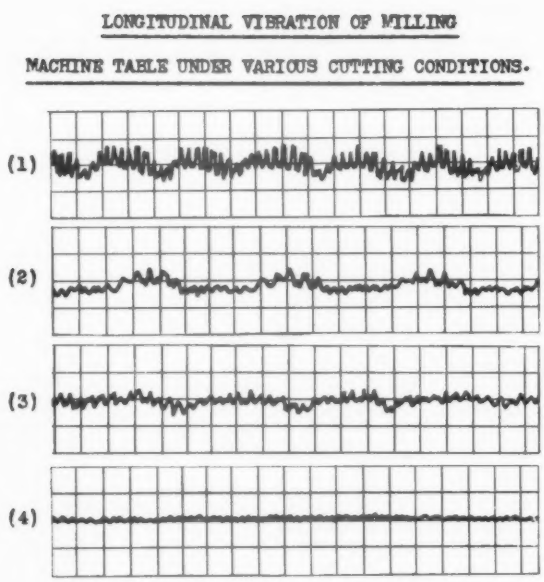

LONGITUDINAL VIBRATION OF MILLING
MACHINE TABLE UNDER VARIOUS CUTTING CONDITIONS.
(1)
(2)
(3)
(4)
(1) Cut 2" wide x 1/8" deep x 6"/min. feed.
(2) " " " " " " 3"/min. feed.
(3) " " " " " " " "
(4) No cut but machine feeding at 3"/min.

Fig. 26(b). Longitudinal vibration of milling machine table under various cutting conditions.

Fig. 26(a). Set-up for investigation into milling machine vibration.

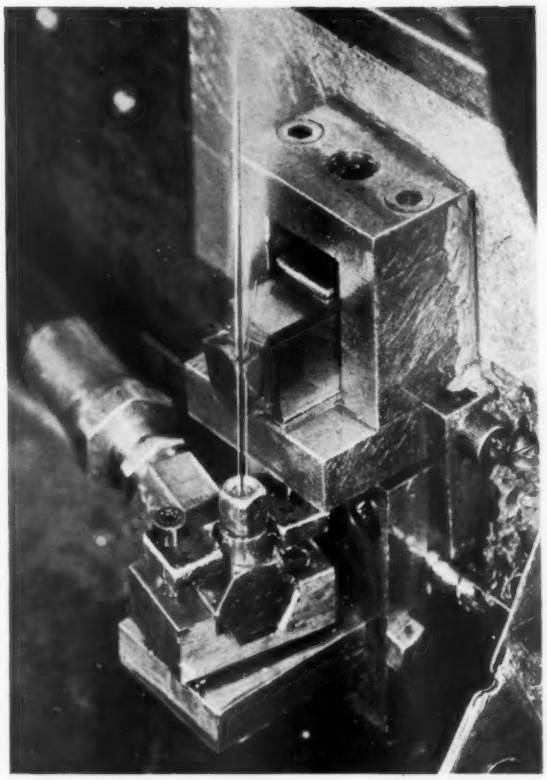


Fig. 27. High pressure jet of oil being directed at cutting edge of tool from below.

speed, life, etc. Fig. 25 illustrates a representative set-up for determining machine tool deflections.

Vibration is a factor which obviously affects the performance, and hence the efficient utilisation of most machine tools. Whether the vibration arises in the machine mechanism or in the cutting action itself, it usually has a very marked influence on output and tool performance, and also on quality of work in the case of finishing operations. Various machining difficulties in industry have in fact recently been overcome by the application of the results of vibration research, and using special equipment developed by PERA for separating out the components of vibration and tracking down those parts causing trouble.

An investigation into milling machine vibration is shown in progress in Fig. 26, which also shows vibration records indicating vibrations associated with run-out of the cutter, and with the cutter teeth, at different rates of feed. Vibrations in operations such as milling can sometimes be overcome without the use of special equipment, but in many apparently smooth operations, for example, finish grinding, minute vibrations are involved which often vitally affect performance and quality of work, and in such operations, the equipment and techniques developed by PERA have proved particularly useful.

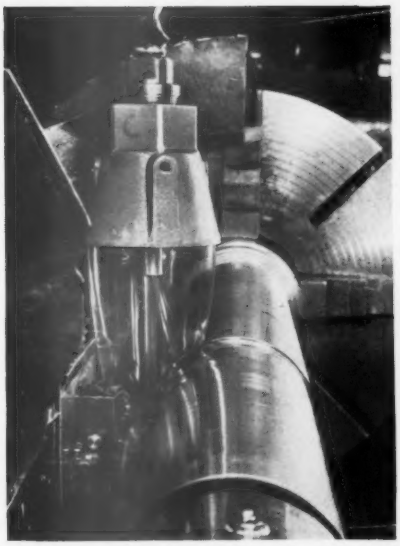


Fig. 28. Oil curtain surrounding cutting area to restrict oil fumes

Investigation of Production Developments

In addition to investigating established production techniques, PERA also conducts research into new techniques, such as the "Hi-jet" method of cutting fluid application, to provide industry with reliable information on the application of these processes as soon as possible. The "Hi-jet" system involves the projection of cutting oil under high pressure into the clearance crevice between the tool and the work, and aimed directly at the cutting edge from below, as shown in Fig. 27, while an oil curtain and an

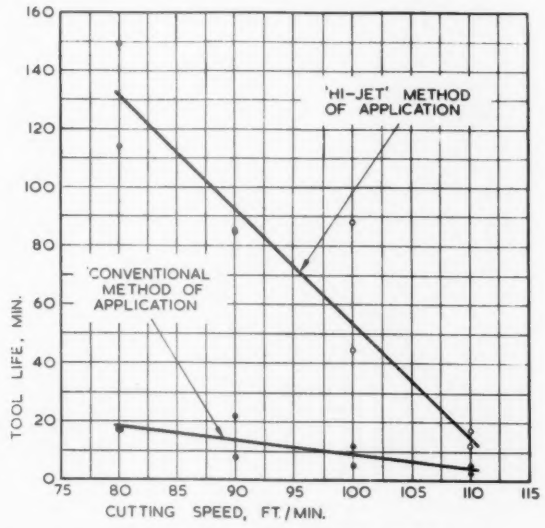


Fig. 29. Results of preliminary investigation of relationship between cutting speed and tool life for "Hi-Jet" system of cutting fluid application.

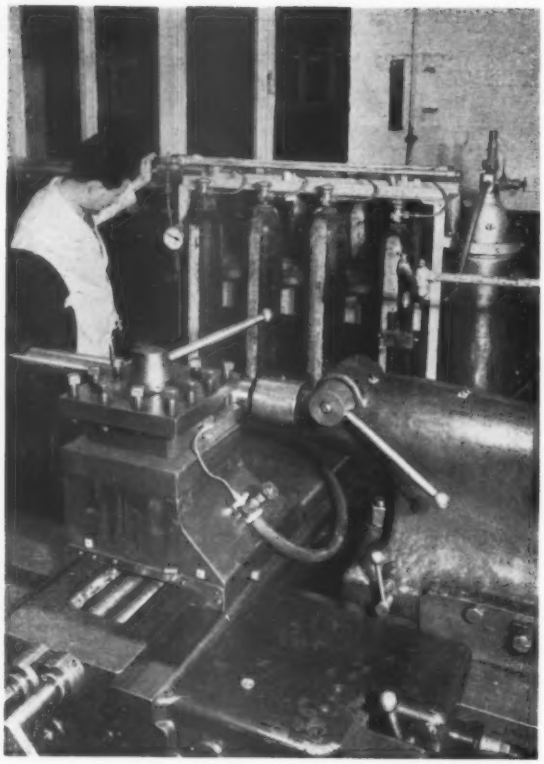


Fig. 30. PERA set-up for investigating the use of CO_2 as a cutting fluid.

overhead flow of oil are used to reduce fumes as shown in Fig. 28.

PERA's investigations of this technique have shown that when turning steels such as En.25 with high-speed steel tools, substantial improvements in tool life are obtained provided that the jets are carefully positioned and maintained in consistent alignment. The relationship between cutting speed and tool life determined in preliminary tests with the "Hi-jet" system of application and a conventional method of application is illustrated in Fig. 29. These results show that the "Hi-jet" system increased tool life by nearly seven times as compared with the conventional method when cutting at 80 ft. per minute, and by about $2\frac{1}{2}$ times when cutting at 110 ft. per minute.

Other production developments which have recently received consideration at PERA include friction sawing and the use of CO_2 as a cutting fluid. The set-up for the CO_2 investigation is illustrated in Fig. 30.

Metal Forming

Present industrial practice in many metal forming operations often depends on personal opinion, and research techniques based on precise measurement of all variables have therefore been developed to provide member-firms with authoritative data. Many forming operations are as complex as machining processes, and some of the factors involved in press-working, for example, are shown in Fig. 31.

Finish Blanking

One of the recent metal-working developments at PERA concerns a finish blanking technique which

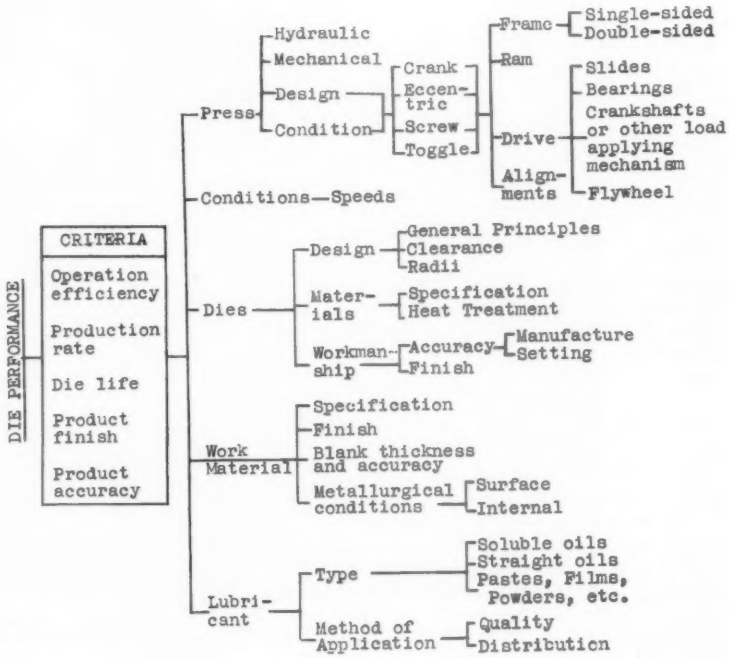
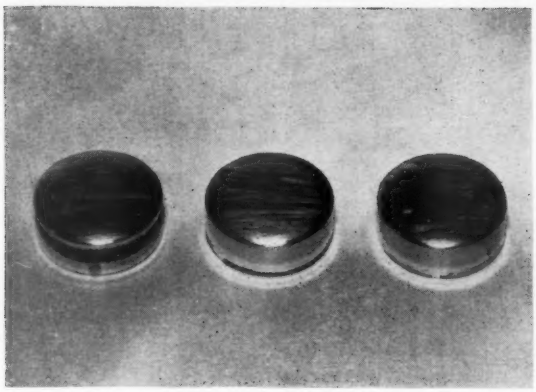


Fig. 31. Objectives and factors affecting performance in press-working operations.



(a) (b) (c)

Fig. 32. Blanked aluminium parts showing the effect of: (a) very small clearance between punch and die; (b) a radiused die; (c) very small clearance used in conjunction with radiused die.

produces consistently smooth edges on blanked components. The usual method of obtaining a good finish on the edges of blanked parts is to employ a machining or shaving operation. The die clearances used in the preceding blanking operation are about 3 per cent. or more of material thickness, as smaller clearances often produce rather ragged edges. In the technique recommended by PERA, the mouth of the die has a definite smooth radius. This procedure alone will not entirely eliminate tearing or cracking, and investigation has shown that blanks with consistently smooth edges are obtained only when a radiused die is used in conjunction with very small clearances.

Fig. 32(a) shows the result of reducing the clearance while retaining a sharp edge on the die. Fig. 32(b) shows the effect of normal clearance when a radius has been applied to the mouth of the die. The high quality of the edge produced by a radiused die and using a small clearance between punch and die is illustrated in Fig. 32(c). The fact that finishes as good as two micro-inches can sometimes be obtained gives an indication of the commercial value of the technique. The severely cold worked smooth edges may also possess improved physical properties, and other benefits may include increased die life, and a reduced tendency for blanks to be drawn back through the die.

Recommendations arising from PERA's preliminary investigations of finish blanking have already been applied in various member-firms with promising results. The technique is being used by one large electrical firm for the production of contactor components of the type shown in Fig. 33. In this case the adoption of PERA's recommendations will eliminate a finish machining operation, and reduce de-burring time from five minutes to two minutes on 50,000 components per annum. In another factory, finish blanking of mild steel car lock parts has led to the elimination of a secondary pressing operation.

Impact Extrusion

Considerable attention has been directed in the last few years to exploiting the advantages of the impact extrusion process, and significant increases in productivity would undoubtedly result from wider application of authoritative data on this process. PERA has therefore been investigating the impact extrusion of such metals as aluminium, copper, zinc, and steel. An impact extrusion investigation is shown in progress in Fig. 34, which also illustrates typical components produced by the process.

Parts which can be made at one stroke of the press using the impact extrusion process sometimes require six or more operations using conventional pressing techniques, and production costs and times, as well as material consumption, can therefore be greatly reduced. The process was introduced many years ago for making tooth-paste tubes in very soft metals, but only in the last ten years have successful attempts been made to exploit its potentialities for the manufacture of components in harder alloys.

Other metal forming processes which are being investigated by PERA include cold heading, deep drawing, thread rolling, bending of sheet metals, wire drawing, etc.

Savings Resulting from Improved Production Techniques

Methods and equipment developed in recent years for research into production techniques have yielded

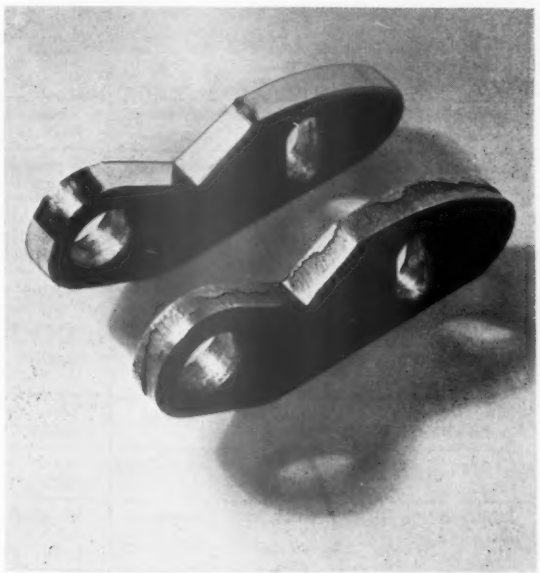


Fig. 33. Copper contactor components produced: (a) with smooth edge by using radiused die on small clearance; (b) with inferior edge using conventional blanking technique. Adoption of PERA's recommendations reduces de-burring time from 5 mins. to 2 mins. on 50,000 components per annum.

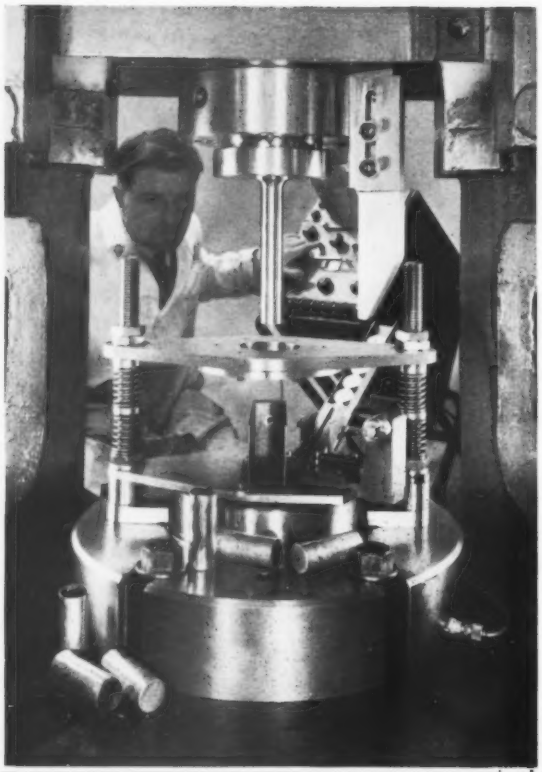


Fig. 34 (a) *(left)*. **Impact extrusion investigation in progress at PERA.**

Fig. 34 (b) *(above)*. **Typical components produced by the impact extrusion process.**

Changes resulting from investigation.	*Increase in productivity and economic savings.*
Redesign of fabricated unit.	Time reduced from 72 min. to 11 min. Cost reduced by 10/- per unit. Rate of production increased 6 times.
Improvements in assembly methods and equipment.	Reduction of assembly costs from £5. 3. 0. per unit to £3. 14. 0. Rate of production increased 45%. Annual saving of £2,900.
Improving set-up for machining operation.	Saving of 11/3d. per component. Tool life increased 15 times. Scrap reduced by 85%.
Assembly of special lamps and other fittings.	Assembly time reduced from 62 min. to less than 13 min. per component. Rate of production increased nearly 5 times. Annual saving of about £15,000.
Improved method of machining drawing dies required in large numbers.	Production time reduced from 53 min. to 22 min. per component. Tool life increased from 5 components to 40 components. Immediate saving of £5,000 on production.
Improvement in assembly method for electrical fitting.	Rate of production increased by 80%. Slight financial savings effected.
Modifications to machine for producing serrated components.	Time reduced from 50 min. to 12 min. Production rate increased 4 times. Cost reduced by 6/- per component.
Change of cutting oils used in machine shop.	Fluids cost reduced by £1,000 per annum, and tool performance improved.
Modified heat treatment to facilitate machining.	Machining time reduced from 51.8 to 42.3 min. Rate of production increased approx. 12%, and drill life doubled. Cost reduced by about 1/9d. per component.
Improvement in tool grinding techniques.	Tool life increased from 3 hours to 10 hours. Grinding time reduced from 20 min. to 7 min.
Substitution of finish machining operation for hand finishing and machining operations.	Rate of production increased over 12 times. Cost of operation reduced by £1,300 per 1,000 components.

Fig. 35. Some examples of economic savings and increased productivity resulting from practical investigations of production techniques.

many examples of higher productivity. Some representative economic savings are shown in Fig. 35.

A particular example concerns the manufacture of drawing dies required in large numbers. Difficulties occurred in the production of the die when the die material was changed, as the new material containing 7 per cent. tungsten was so difficult to machine that cutting tools required grinding every five components or less. It was also extremely difficult to maintain the standards of accuracy and surface finish specified. The machining times for the dies was initially 24 minutes, but research reduced this first to 9 minutes, and finally to 7½ minutes while tool life was increased to forty components. Three separate machines were originally used in the manufacture of each component, but a procedure was developed for machining the dies on a capstan lathe. This facilitated production, reduced handling time, and ensured dimensional accuracy, with the result that the total manufacturing time was reduced from 53 minutes to 22 minutes per component, and costs were reduced to less than half, thus effecting an immediate saving on production of about £5,000. The special tools developed by PERA are shown in Fig. 36.

Another example of higher productivity resulting from PERA's work involved the slight re-organisation of a small general assembly bay, and improvement of the equipment used. Two PERA engineers, supported by appropriate research facilities, made an analysis and prepared recommendations involving minor changes in equipment and lay-out. The modification of mechanical aids and the lay-out of the bay involved an expenditure of less than £250, but the changes resulted in an increase of 45 per cent. in production, and reduced the average cost per assembly from £5. 3. 0. to £3. 14. 0. The saving in the first year was £2,530, and in subsequent years this increased to £2,900 per annum.

Although the engineering industry has for many years conducted an increasing volume of research into the development of new products and improvements in the design and performance of existing products, only comparatively recently have the advantages of co-ordinated research into production engineering techniques been realised. There is already ample evidence, however, that the application of existing research results will increase the speed, economy, and quality of many production processes to levels well above those prevailing in most firms, and there can be no doubt that a common research effort sustained by the whole engineering industry would make a substantial contribution to the general increase in productivity which must be achieved for this country to be able to meet with confidence increasingly severe competition in export markets.

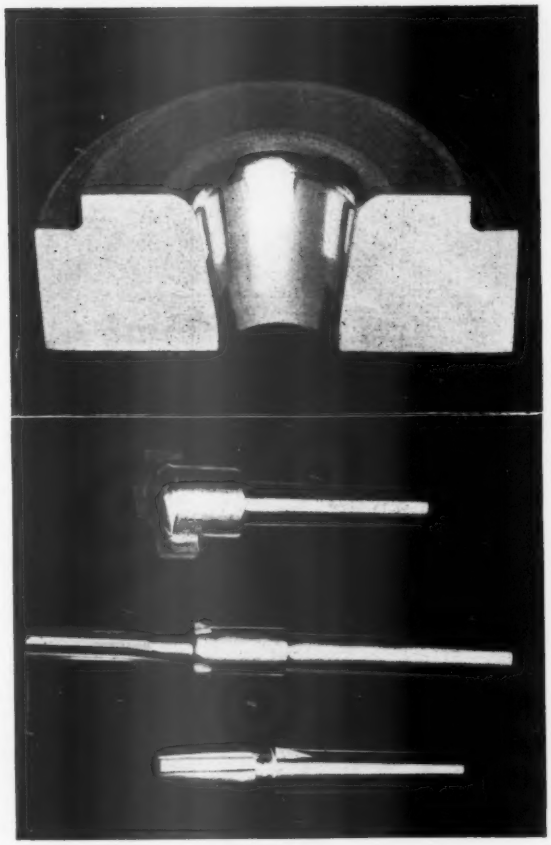


Fig. 36. Special tools developed by PERA for the production of drawing dies, as shown above.

BRITISH STANDARDS

The following Standards have recently been issued and may be obtained, post free, at the prices stated, from the British Standards Institution, British Standards House, 2 Park Street, London, W.1 :

B.S.1498 : 1954.	Gear Hobbing Machines for turbines and similar drives	(4/-).
B.S.2457 : 1954.	Protractors for drawing office use	(2/-).
B.S.2458 : 1954.	French curves for drawing office use	(2/-).
B.S.2459 : 1954.	Set squares for drawing office use	(2/-).
B.S.2460 : 1954.	Drawing instruments for drawing office use	(2/-).

PRODUCTION ENGINEERING RESEARCH AND THE INFORMATION SERVICES AT WORK IN THE FACTORY

by W. P. KIRKWOOD,

B.Sc., M.I.Mech.E., M.I.Prod.E.

Educated at Glasgow High School and Glasgow University, Mr. Kirkwood graduated B.Sc.(Eng.) in 1921. He served his apprenticeship with Albion Motors, Limited, Glasgow, and subsequently spent a few years in the Drawing Office and Design Department.

He later changed over to the production side as Assistant to the Works Manager and then became, successwely, Inspection Superintendent, Production Engineer, and Assistant Works Manager. He took up his present appointment as Works Manager in 1951.

Mr. Kirkwood has been actively connected with the Glasgow Section of the Institution of Production Engineers for many years, both as Committee Member and Hon. Secretary, and has just completed two years in office as Section President.

He is also a Member of Committee of the Automobile Division, Glasgow Centre, of the Institution of Mechanical Engineers.

Mr. W. P. Kirkwood

THE methods and the equipment of production engineering research have been described by Dr. Galloway. He has also given examples of some of the practical results obtained in industry.

It is now proposed to describe the application of some of these research results in the factory of a PERA member-firm. After all, it has to be remembered that the whole object of these is to improve techniques in industry, so that the full benefit of the results of research can be reaped.

In this respect, production engineering research is very much more favourably placed than most other forms of research. The reason is that the results can usually be put into practice more quickly. Also, it is very often possible to forecast the economies which are likely to be obtained by the new techniques. This has many attractions in a competitive world.

The principal obstacle to the most effective use of research results is the lack of co-operation by industry itself. The existence of an unco-operative attitude in a firm can often be traced to unsatisfactory results obtained when attempts have been made to apply published information, which, unfortunately, is often incomplete and consequently of little real value. When essential information is omitted from an article or report, the application of the technique in the workshop almost inevitably gives bad results, or, at best, results which fall far short of the claims made.

The claims made for new techniques developed as a result of systematic research are sometimes less spectacular than the claims made for techniques devised as a result of experiments made in workshops, but controlled investigations provide data which is much more reliable than that obtained in

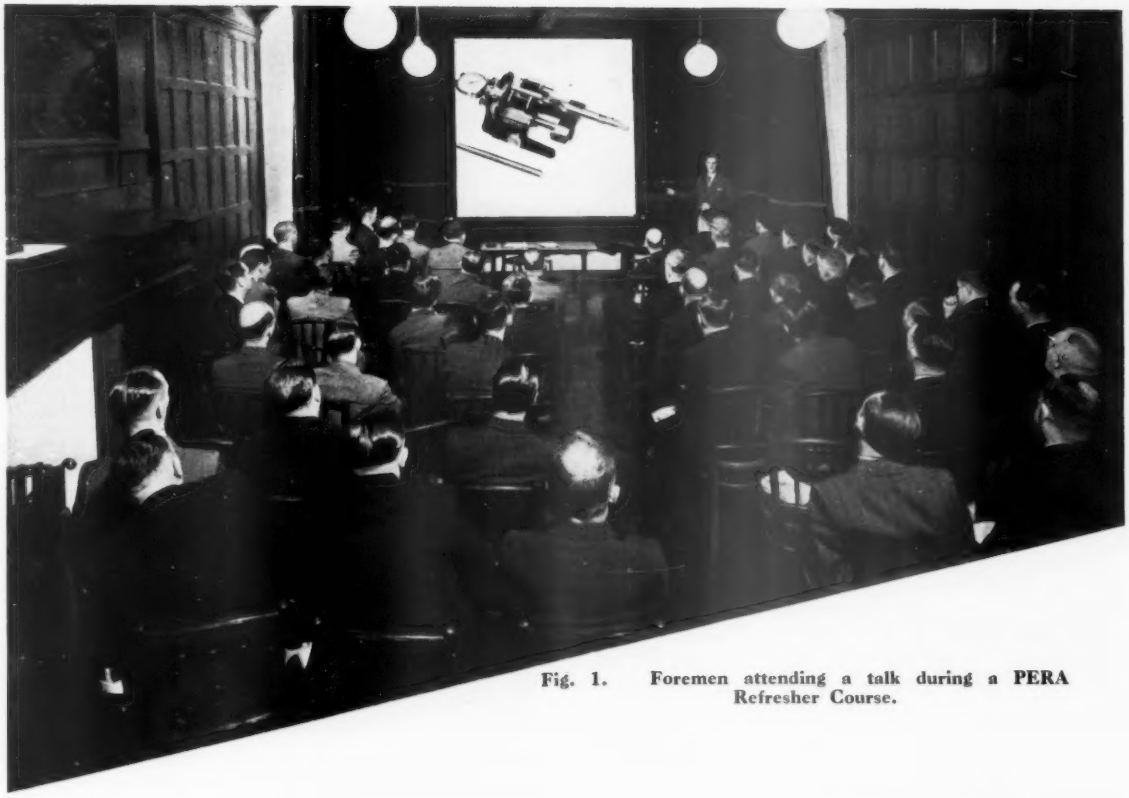


Fig. 1. Foremen attending a talk during a PERA Refresher Course.

uncontrolled tests, and the research results can be applied in any factory with complete confidence. Because of variations between one factory and another, some differences inevitably occur in the final practical results obtained in different factories, but this does not affect the soundness of the recommendations made.

PERA has developed various ways for passing on the improved techniques to industry. Each of these ways has a function of its own to perform, and there is no sense of overlapping between them.

Practical Demonstrations

One of the most practical methods of getting production research results applied is the actual demonstration of the processes by PERA staff at their headquarters at Melton Mowbray. This has been one of the most successful and most useful of the Association's many services. It is particularly helpful in cases where the process is new and, therefore, sometimes suspect.

There are, in most works, foremen and technicians who are extremely sound men, but who take a very critical view of new ways of doing things. If they actually see the methods in operation, this can convince in a way in which no written matter can. It also has the great advantage that points which may cause doubt in the minds of those seeing the demonstration can be raised there and then, and the results qualified or amplified in order to satisfy the enquirer.

These practical demonstrations can also be used very effectively where an individual has to be trained in some new process, for example, tool grinding. Such instruction can often put the man on the right road comparatively easily. The general level of cutting tool efficiency is a good deal lower than it would be if existing research results were properly applied. Member-firms whose personnel have attended PERA's tool-grinding courses have therefore reported substantial increases in tool life. Even highly skilled operators cannot produce the maximum amount of work without well-designed and properly maintained cutting tools, and firms who have now realised this fact are sending foremen and other production workers on such " refresher " courses. These courses also enable the progress of the Association's researches to be studied at first hand.

Six-month Student Courses

For young engineers there are student courses which last for six months. At first sight, to send a young man to PERA for six months and pay his salary and lose his services, can seem a procedure likely to be difficult to justify from the point of view of the return obtained. The young man may leave

Fig. 2. Part of PERA tool grinding demonstration facilities.

before the company concerned can get their money's worth from him. This is something which can happen at any time in an organisation with a young man in training, and the fact that it does happen from time to time does not mean that young men should not be trained. So it is with the student courses.

During this period the student helps the research engineers in their work, and is able to get a sound working knowledge of the proper methods of approach to any investigation. The course develops in the young engineers an analytical approach to everyday production problems and the general improvement of production methods. This is an invaluable experience. How often in the shop is it found that when a problem arises, and the pressure of production is applied to get a solution quickly, there is the inevitable temptation to change two or more factors at the one time! This is quite wrong, because while immediate problems can sometimes be solved by such methods, it does not make for security in the future, in that it is not known which altered factor made the difference. A course with proper research training can do a great deal to help a young man to fight against this disease.

In the Author's company, the present Assistant Tool Engineer went through this course two or three years ago and he is, as a result, very much more capable of carrying out his duties today than he would have been if he had not had this advantage.

Member Liaison

Production research must keep pace with the needs of industry and to do this, the man engaged in the actual work of research must be in touch with industry constantly, knowing what is happening and the needs that are arising. To do this, Member-Liaison visits are carried out by the staff of PERA. The number which can be worked into a year is of the order of 250. During these visits the research engineer is able to meet and talk to quite a number of the technical personnel, and is sometimes able to give help on the spot.

Library and Information Services

Two of the most practical services which PERA provides are its Library and Information Services. A vast amount of information is regularly published on a wide variety of technical subjects. Few firms have the personnel available to collate this in a really satisfactory manner, and thus make the required information available at short notice to anybody needing it. PERA has developed special methods for dealing with all such technical information. Since its inception, the collection, classification and cataloguing of all these items of information on production techniques has been indeed a formidable task. In its first five years PERA has built up a Library of about 100,000 units of information, i.e. books, articles, periodicals, special trade literature, etc. They have also built up a system of indexing so that

Fig. 3. Tool angle protractor for workshop use being demonstrated to production personnel at PERA.

this information can be looked up quickly and accurately, and members informed, on enquiry, of what is known about the particular subject.

PERA Bulletin

Another widely used information service is the monthly Bulletin, of which nearly 4,000 copies are issued each month. Each contains approximately 500 abstracts of recently published information, all properly classified under various headings for ready reference, so that those in industry can quickly put their finger on matters which are of interest to them, and thus keep themselves up to date without wading through a mass of reading. The value of the Bulletin is enhanced if the copies circulating in a factory are sufficient to ensure that a large number of those interested do in fact have access to this information. In the Author's company, which has approximately 3,000 employees, 20 Bulletins are obtained, and these in turn circulate to over 100 members of the staff. This means that all these men have the opportunity of keeping themselves up-to-date on a variety of subjects which are of interest to their particular department and job.

As a result of reading these Bulletins and abstracts, further information is often requested on points which are of detailed interest. In such cases, reprints of the complete article referred to can be supplied on demand. More than 160,000 reprints of articles

Fig. 4. Two young engineers attending a PERA six-month course receiving guidance from a member of the Association's staff in planning an investigation.

summarised in the Bulletin have now been issued by PERA.

It is interesting to note that departments not directly concerned with production, such as the Metallurgical and the Plant Departments, are responsible for an appreciable number of such requests for reprints.

Technical Enquiry Service

For dealing with members' requests for assistance with particular problems, a Technical Enquiry Service has been established. This applies where the need for some more detailed information than contained in a single reference is required. Information

Fig. 5. A PERA engineer at a member-firm pointing out the advantages of improved drill grinding.

Fig. 6. A part of PERA Library.

on a particular process or method may be needed, and the way to obtain this may not be known. The Technical Enquiry Service will look up their records and give the information required, where this is available. If it is a simple question the answer may be given by return of post, but if not, then the information will be given as soon as it can be brought together. Some 4,000 of these technical enquiries have been dealt with since this service was introduced by PERA some five years ago.

Industrial Control of PERA

One of the most important branches of PERA's research is that which is concerned with production techniques of common interest to the members of the Association. These subjects must be selected with considerable care. The main body responsible is the Technical Policy Committee, which is composed of members from industry, who have a wide knowledge of the needs of their own organisation. After the general scheme has been approved by this Committee, the detail control is passed on to various other Committees who deal with special aspects of research, such as Metal Cutting, Metal Forming, Machine Tools, etc. These Committees are also composed of men from industry who can bring the weight of their practical knowledge to bear in the various discussions on the type of research required, and the direction that it should take. They are also responsible for the final approval of the results before the report is published.

A number of these reports has been issued in the last few years. This will increase regularly as time goes on, and this year, about eight reports on full-scale researches have already been issued.

Each organisation must take these reports and see that they are put in the hands of all the various people who can make use of them, depending on their subject matter. Some have application beyond the purely production aspect. For example, a report issued by PERA on tapping and the relation between core hole size, tapping torque, and thread strength, is really a matter which must be dealt with by the Design Department. The use of considerably truncated threads, which have been shown by PERA to be as strong as fully formed threads, can do much to ease the problem of tap life and the cost of tapping. Designers can now take advantage of the proposals given without fear of the results being unsatisfactory.

Economic Returns from Research Results

Until now the general service which research can offer to industry, and the methods being used in the factory to take advantage of it, have been described. What about results? These are often hard to put into £. s. d. At the same time, many firms who have made use of the facilities offered can, in fact, make some assessment of the benefits which they have got from their association with research.

In making such assessment it is well to note that

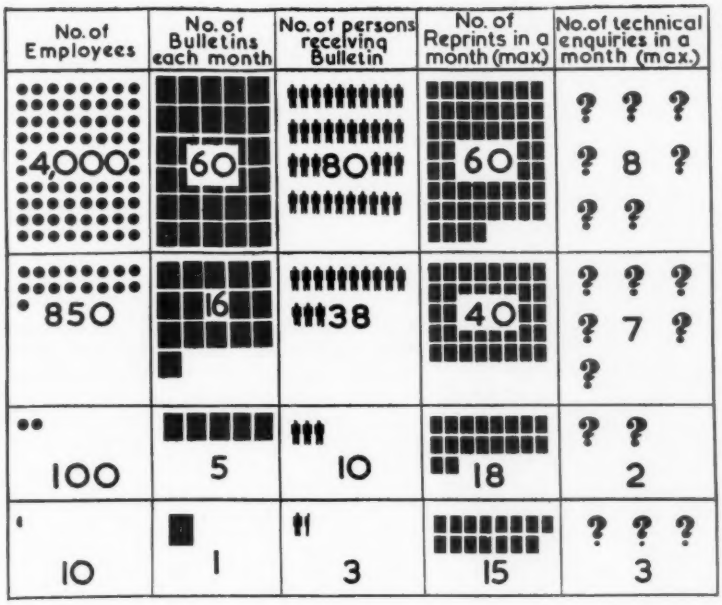


Fig. 7. Summary of use of PERA services in typical firms of different size.

USE OF INFORMATION SERVICES

the return may be considerably greater in any specific instance than first anticipated. This is because attention having once been focused on a particular problem and a solution provided, the same approach can be used to deal with other problems which would not have been tackled in this way but for the initial solution provided by research. One or two examples from the Author's organisation may make this point clear.

In 1949 and 1950 reports were issued on Soluble Cutting Oils. These drew attention to the fact that, like many other firms who have to do a considerable amount of machining, it had been taken as accepted practice that certain operations should be carried out with soluble oils, and certain other operations should be carried out with straight cutting oils. From these PERA reports it became obvious that some of the operations, on which straight cutting oils were used, could be carried out equally well with soluble oils. This led to a wholesale change-over from straight cutting oil to soluble oil on quite a number of machines. In fact, it was found that in many cases the machine itself determined what could be used and not the process. Some of the machines were so made that they allowed soluble oil to get into the bearings. This was noticed in time before trouble took place, but straight-cutting oil had to be put back into these machines.

This itself is illuminating, because it is a serious reflection on the machine tool industry that such a state of affairs should exist, and it is suggested that if there are any machine tool designers present, they should take note of it. Unfortunately modern machines can still show such defects.

The net result of the change-over is that it is estimated that a saving of over £800 per year on this one point has been achieved. Not only that, but now that attention is focused on this question of cutting oils, possibilities of still further economies can be hoped for in the future.

A second example, also concerning the Author's company, is the sharpening of drills. For years all drills have been sharpened on recognised machines of well-known makes. These machines have, on the whole, given reasonable service, but as a result of information which has been obtained from PERA, a check has been made on the relief angles which the machines have been producing on the drill points. It is found that, in many cases, these angles are not being ground to the required figure. This is because no known drill sharpening machine on the market is properly calibrated to give the required relief angle for all the different sizes of drills within its range. Some machines have a scale which is a

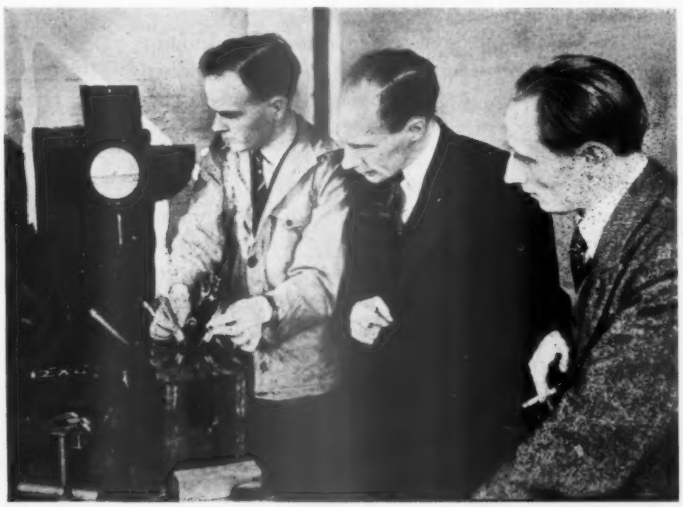


Fig. 8. Commercial crack detection apparatus being demonstrated in PERA workshops to a representative of a member-firm which requested assistance in detecting internal cracks in steel billets.

Fig. 9. Production personnel and executives from engineering firms discussing press-working developments in PERA workshops.

guide, but it is no more than a guide. Now that this point is realised, it is hoped that by checking up various sizes of drills which have been ground to various settings, the machines can be calibrated so as to give proper control of this important feature.

It has been found from research that the optimum relief angle ranges from about 10° to 12°, depending on the type of drill and the material being cut. The tolerance for best results is thus comparatively small.

A third example concerns the flaring of pipes. A large number of small pipes have to be flared in order to fit a special connection. In the old days this was done by a simple hand tool, which was quite satisfactory for copper pipes. Due to the rising price of copper, attention was directed to the brazed steel type of pipe, which demanded a double back on the flare. Two very slow hand forming operations were then needed. No machine could be found on the market to carry out the operation quickly and efficiently. It was, therefore, decided to design a machine. The drawings were prepared and the machine priced. This came to a figure of around £600. It was felt right away that this figure was far too high, and that there should be a better method of doing the job.

At this stage PERA were asked for their suggestions. The idea of doing this job on a crank press with a two-stage tool was the result. The crank press was cheap, under £200, and the tools also were reasonable in cost.

The job therefore went ahead, and it was found

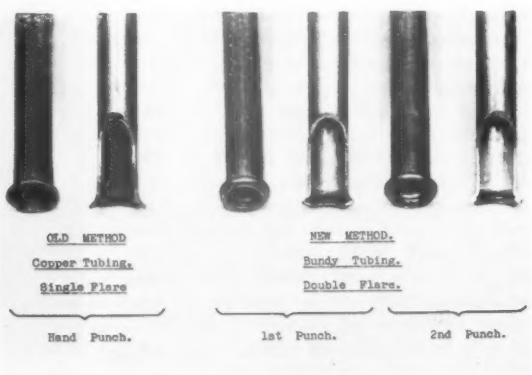


Fig. 10. Old and new methods of flaring copper tube.

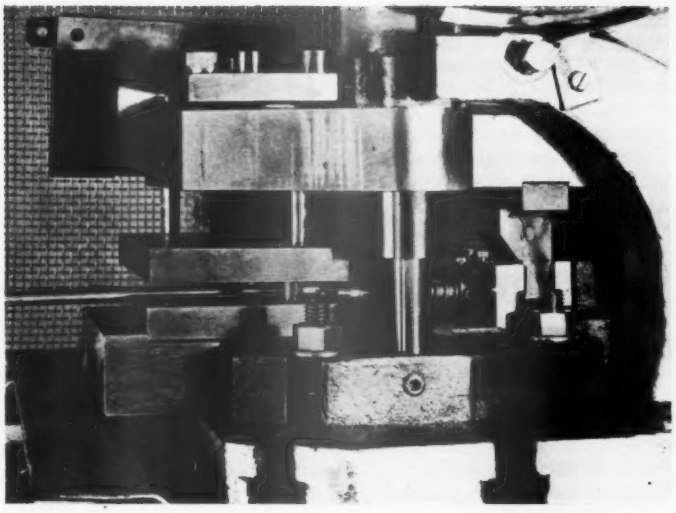
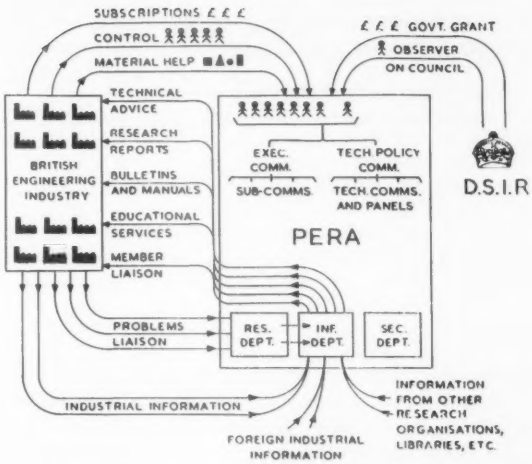


Fig. 11. Side view of tools suggested by PERA for flaring of tubing.

that the results were very gratifying. A saving of something like £350 on capital outlay was achieved, and the job which was done in the old days at the rate of one every $1\frac{7}{8}$ minutes was now done in 15 seconds.

These examples show the return that a firm can get from research properly applied. Many other companies have reported similar results to the Association, and there is no doubt that most engineering firms could make equally good use of PERA's services.

The continuous flow of information from PERA to industry has been referred to in this Paper, but in the Author's opinion this flow should not be in one direction only. It should be two-way, with information flowing into the organisation from industry, as well as to industry from the research station. In this way, all can help to raise the general level of manufacturing efficiency in this country. If there are no clear lines of communication between a firm and a source of reliable information, the firm may not know where it can obtain the up-to-date information it needs. In some cases, indeed, it is not even realised that the need exists. Considerable progress has been made in Britain by creating a central organisation from which authoritative information can be obtained readily, but it is essential for industry to make the maximum use of these services and also, in due course, to be prepared to assist other firms by contributing to a common pool. Every organisation which makes effective use of the production engineering research facilities that are available in this country is making a direct contribution to national prosperity, as well as helping to ensure its own success.



PERA AND THE BRITISH ENGINEERING INDUSTRY

Fig. 12. Relationship between PERA and the British engineering industry.

RESEARCH PUBLICATIONS

A number of copies of the following Research publications are still available to members, at the prices stated :

Report on Surface Finish, by Dr. G. Schlesinger	15/6
Machine Tool Research and Management	10/6
Practical Drilling Tests	21/–

These publications may be obtained from the Production Engineering Research Association, " Staveley Lodge ", Melton Mowbray, Leics.

THE TRADE UNION ATTITUDE TO RESEARCH AND PRODUCTIVE EFFICIENCY

by JAMES CRAWFORD, F.B.S.I.

Mr. Crawford, General President of the National Union of Boot and Shoe Operatives, is a member of the General Council of the T.U.C., and Chairman of its Production Committee.

He is also a member of the Advisory Council of the Department of Scientific and Industrial Research, and a Visiting Fellow of Nuffield College.

Courtesy Daily Herald
Mr. J. Crawford

THE title of my paper suggests a question—" Is there a Trade Union approach to this problem as distinct from a Management approach, or the approach of the technician?"

The answer is surely in the affirmative. Trade Unions exist for a specific purpose. Their main function is to promote the interests of their members, defend established rates and improve them, and legislate in various ways for new conditions. They were not created to seek the *common* good, to think in terms of *national* welfare. They were Sectional, princ - pally to defend, to worry and to fight for the interests of their members.

The Trade Union movement in its early stages could only be expected to think in terms of immediate objectives. How could it do otherwise? Employers planned as they pleased (if planning really is the right word). They thought only in terms of hard work, and labour was no more than a necessary evil. Owner-management was common and often secured upon hereditary claims and not always on merit; at its best it was paternal, distributing largesse in the form of concessions which would have been vigorously condemned if sponsored by a worker's organisation.

We have travelled far since those days, and management and the workers' organisations have come closer together, if not in function which could not be expected, at least in broader understanding and in the realisation that fundamentally there must be agreement on certain broad principles.

It is a law of nature that when a community is threatened from without, first things come first; differences are forgotten and unity against the enemy is essential. That happened in 1914-1918 and 1939-1945.

There is, however, a significant difference in continuity of good industrial relations. Whereas after 1914-1918 the industrial relations of wartime barely survived the Armistice, following the more recent War, the value of good industrial relations is more fully understood now than at any time since the end of the war.

A Common Stream of Thought

In my view there are many reasons for this continuity of purpose and intention, yet all are tributaries reaching a common stream of thought.

We all know now, with the virtual disappearance of our foreign capital and investments, how precariously our economy was balanced before the War and since the War. We know that our standard of life before the war came from two sources—our day-to-day productions and effort, and our imports based on past achievement. We therefore deduce that for many years, whilst our foreign interests were being enlarged, we were enjoying a standard of life not earned from day-to-day and must now stand on our own feet.

We know we like our political independence, and a proud race likes to be economically independent. These are the things we all know.

Management knows that whilst the first loyalty is to the industrial concern, that alone is not enough. We sink or swim together. National bankruptcy will destroy the most efficient firm, so the national interest is an ingredient of modern management thought.

The Trade Union movement knows that the more there is in the kitty the more there is to bargain for.

Fundamentally, we are all in the same boat. The failure to solve the economic problems confronting us within terms of conciliation and arbitration between management and men will intensify our difficulties. This fact pre-conditions our relations, and must continue to do so as industry, line and functional management, and operatives are more and more interwoven in the industrial tapestry. This interweaving, this warp and woof of relations, does not mean that the Trade Unions in supporting modern management methods will rubber stamp the decisions of management, surrender its bargaining position, or regard the stop watch as a totem pole and the industrial engineer as wearing the mantle of infallibility. Indeed, far from it.

Industrial Relations

It does mean, undoubtedly, certain quite revolutionary changes in Trade Union training, in personnel, type of officer, no doubt also a complete break with traditional practice. But it really means also an extension of the boundary of Trade Union activity—not less bargaining, but more. It also means that management generally must also conform to the new circumstances and let its own hair down.

Scientific and technical development is imperative to solve economic problems and to raise living standards, *but not at the expense of the human factor*, otherwise the means get mixed up with the end. Technical efficiency, after all, is only the skeleton of industrial efficiency; it will be more presentable and acceptable after being "humanised" in the course of joint trade union and management discussions.

The point I want to make, then, is that modern management methods are part and parcel of industrial relations; they can no more be left outside joint negotiations and consultations than the earth can be left out of the solar system. Insofar as good relationships depend on confidence and goodwill, nothing is more likely to destroy them than the suggestion or the rumour that the introduction of new production processes, factory changes of one kind or another, or the use of work study and other techniques are to be considered and determined solely by management.

Despite a small minority of voices, Trade Unions recognise that management must manage and make final decisions. We do not think this is management's right or prerogative; we think it their responsibility—a responsibility which would include that of taking into account everything which the workpeople's representatives might wish to say about changes or developments, and a willingness to negotiate if necessary on related wages and working conditions.

The Urgent Economic Problem

The extreme urgency of our economic problem underlines and emphasises the human factors involved. The industrial revolution of the last century was not one single event but a series, all culminating in a conquest of nature and its elements, making possible a higher standard of life than ever before. It created new problems because inventive progress was far ahead of social progress and understanding to cope with the results.

Compared with a century ago we now produce four times as much coal or iron, four times the quantity of bricks, new materials, fibres, plastics, motor cars, and extract nitrates from the air on the point of a needle. The population has more than doubled; output per worker is five times what it used to be. We work shorter hours—not longer.

The other side of the picture is that we depend on imports for:

Half our food.
Half our iron-ore.
Four-fifths of our wool and soft woods.
Most of our aluminium, lead, zinc, copper and tin.
All of our petrol, cotton, jute, sulphur and rubber.

In our search for a solution to our present problems let us learn from the past, and match industrial and economic progress with social results which will preserve the harmony of our industrial relations.

The things we must import in order to live cannot be bought by signing cheques. They can only be obtained by selling equivalent goods abroad. These can only be sold if quality and price are right—and in competition with others.

In order to satisfy all these requirements, management, technicians and craftsmen must be far more efficient than ever before.

Production and Research

I have just been reading the Sixth Report of the Advisory Council on Scientific Policy. In the introductory paragraphs, the Report again draws attention to the widely-held view that the technical backwardness in large sections of British industry is due to the failure to exploit the results of scientific research. It has become platitudinous to say that, whilst we hold our own in the field of pure science, we

lag behind other countries in the application of science to the development of new processes and new manufactures.

We do much better today than we did before the War, but we are still far short in volume of the research and development done by the U.S.A. and, so long as we have to compete for that market and meet American competition in other countries, the difference is vital to us as a manufacturing nation. Some of our large firms are as advanced in science and its application as any in the world, but others are content with the minimum of technical change.

The demand for scientists and engineers, for the product of universities and technical colleges, must come in the first place from increased recognition of their importance in industry. As the Todd Report says: "They cannot impose themselves uninvited upon industrial firms in this country."

I believe, however, that there is a greater awareness today of the fact that we live in an island which is economically besieged. This awareness has not yet penetrated the remote fastnesses of the most conservative minds. (I am using the word "conservative" not in a political sense, but in its wider connotation.) If we continue complacent in this regard, we will have a rude awakening. We need today more scientists and engineers in our workshops and laboratories and also in our board rooms.

The late F. E. "Galloper" Smith, later Lord Birkenhead, spoke of the glittering prizes open to thy young and adventurous. I think in terms of better craftsmen, better managements, new and better products from our industry, and I see the day coming when the industries of this country will be completely seized of this quintessential and will seek out the bright product of the Technical College and University.

The Need for New Ideas

This must be recognised for a real appraisement of our present situation. The world and its people change every day; their needs change; their habits change; new industries are developed—new materials, new fabrics, plastics, synthetics. A nation trading for all its people is no different from one manufacturing concern trading in its own native country. If it wants to live and continue living, it must keep abreast of the times.

I think of a town of six shoe factories fifty years ago; there is only one now. No one could beat them at their own line. It wasn't competition that beat them—it was ideas. Similarly, I know of a town of two engineering firms, mostly on agricultural implements. Nobody told them that ideas have legs—nor even caterpillar wheels. These two firms are now out of business.

As the Scientific Policy Report says, we can hardly expect to live by our industry unless we change the pattern of our production and seek to develop new products and processes which, by depending on the application of our scientific and engineering skills (and these are as good as those of any other country), will keep us in the forefront.

A particular case in point is the aircraft industry—but many more are needed. The development of the jet-propelled aircraft has put us ahead of the world, despite the temporary setback to the Comet fleet. Here is a development by British brains which we pilot through the experimental stage and manufacture here and allow manufacture abroad on licence.

British brains discovered penicillin—but the exploitation of it, the commercialisation, has been done mainly abroad. The period of time of the discovery found us at war and at a disadvantage but, even so, our own determination and resource should have been equal to the additional burden.

Today it is not merely a question of making our traditional goods and services in new ways, of even better quality and craftsmanship, of learning how to process goods and transport them better in our factories, of raising production per man-hour—not by working harder but by working more effectively—but, even more important than these things, we have to develop new products to replace old but well-tried goods which the march of time is rendering obsolete, and so keep ahead of the forward thinkers of the world.

This insistence on forward thinking, on new methods and ideas, the reminder that the Todd Report was critical of British management's receptiveness to new ideas, provided the Trade Union movement with no alibi. We cannot endorse such conclusions without facing up to the implication for us, namely, that if British industry becomes more receptive, adapts itself more quickly to change, invents new processes, fabrics, or methods, it should not be obstructed by management or the Trade Unions from adopting the new idea and contributing towards the economic solution of the nation's problem.

This possibility again emphasises the importance of the human factor. New ideas are more easily embraced where management and labour have established the greatest degree of confidence in each other, and where each side has respect for the interests of each other.

Most of the research in this country is undertaken by private firms and institutions. There exists, however, Government-sponsored research, the industrial research associations attached to various industries, partly financed by Government grant through D.S.I.R. and partly by the industrial members. The T.U.C. has two members on the Advisory Council of D.S.I.R. but it is regrettable that out of over 40 of these co-operative research bodies, only twelve of them have Trade Unionists on their Councils and functional committees.

A Serious Reflection

This is a serious reflection on management. It is a failure to recognise that every aspect of research touches the human factor very closely. A new machine may alter the incidence of price per operation; a new fabric or adhesive may change a traditional method and thus cause repercussions which impinge without warning on the consciousness of workers, and the mental disturbance is reflected in suspicion and lack of co-operation.

This sort of thing is avoided for the most part where the workers are in on the ground floor and have, indeed, shared the decision that particular investigation should be authorised.

The urgency of our present economic problems has led to the establishment, in many research organisations, of an Industrial Division, the main function of which is the comparison of present efficiency, thus logically developing towards the least efficient aspiring to that of the highest.

Shoe and Allied Industries Research Association

Surveys of this kind have been carried out by the Shoe and Allied Industries Research Association on factories making the same type of shoe, all with the co-operation of my Union through our full membership, financial and functional, on the various committees. For example, one survey of 12 factories making men's Goodyear welted shoes revealed that, in making 12 standard pairs, the man-hours varied from 12.34 in the least efficient to 7.30 hours in the most efficient. It was also revealed that if the efficiency of all 12 firms were raised to the *average of the three most efficient*, there would be a saving of man-hours of 20%.

There is no value in such surveys without a lesson being learned and, as no part of the difference was due to equipment, machinery, or superior workmen, any change to be made would be either layout, method, work transport, planning etc. all touching the human factor and vitally affecting the operatives concerned.

The science of ergonomics is rapidly developing. What more important type of activity can a Trade Union be associated with and how better than through these research bodies?

As the principles of motion economy develop, more and more will the Trade Union movement interest grow—not limiting its boundary to what is provided in the way of machinery and equipment for its members to operate, but stretching out to demand that machinery companies and manufacturers, management and technicians, develop machines and machine controls which reduce fatigue and make work easier.

In our close association with Satra House we are with them in a Conditional Aid research on machine controls in the shoe industry, but before developing ideas of new controls close study is necessary of existing controls and the performance attained thereby.

The first investigation of performance was made on a group of Derby Side operatives, from each of whom records were obtained covering several days. It was found that, on average, their machines were stitching for about 20% of the total working time. The average length of time of a run of stitching was .90 sec. and the machines were stopped and started about 800 times per hour. For one type of Derby Shoe the overall time was 83 seconds. This time was divided as follows :

Preparation (fetching work, tying and untying etc.)	15%
Machining (machine running)	18%
Manipulation of work	67%

The operatives were highly skilled and the equipment and organisation were of a high standard, yet surely 18% machine running can be improved upon. Yes—but how? And upon whom will any change be mostly made? Whatever the change required, the evidence of its necessity arose from a survey, the decision and direction of which their own organisation shared.

We regard these research organisations as instruments of great potential value, not merely the preserve of management and technicians, but also of those who are affected by new ideas. We want more co-operation in this field—not only to watch the development of the skilled scientist, but to add to his knowledge; to throw into the common pool of ideas the experience acquired over many years of real craft knowledge.

Application of New Techniques

The new techniques involved in modern management methods have, in general, the support of the Trade Union movement. It is agreed that acceptance is not uniform or evenly spread amongst the Unions—nor even within each Union. Resistance seems stronger in certain geographical areas than in others. The malpractices of some years ago leave a lingering memory behind and even now too many managements think too exclusively of cash incentives without undertaking, as a prerequisite, the study of methods, supervising and general organisation, work transport, adequate reserves of work in progress, and improving them before the use of the stop-watch is allowed.

This type of management is the biggest enemy of new ideas. Its thinking cannot cope with any idea beyond " harder work."

The Trade Union view of the use of this term is that it is bad psychology, not necessarily true and, whilst the degree of application to the job varies industry by industry and even within the same industry, there is real need to remember that just as a unit value of work is an amalgam of work and rest, so work is an amalgam of mental as well as physical activity.

It is my own experience that, without preplanning, British workers often work harder than American workers at an average pace, although they do so in short spurts of activity to compensate for enforced idleness. The effect on mental equilibrium, however, is continuous and foreign to the mental peace engendered by thorough planning of the work load. Let us agree to talk a little less about hard work and more about effective work.

A Confusion of Ideas

There exists today, despite all the avenues of knowledge available, confusion between production and productivity. Productivity should be used as the word to define the ratio between output and input in a plant, an industry or an economy as a whole. Because we most often use the yardstick of " production per man-hour," too many people place the responsibility for low production per man-hour on *only* the human aspect of input: these people forget, or have never been aware, that the term is only used because it is more convenient, and there is a greater availability of man-power data.

Input means labour, capital, raw material, etc., so that if only one of the factors is used as the most suitable reference, do not confuse the issue by placing

all the responsibility on labour, unless, of course, management is also prepared to pass over to labour all the benefits of such increased productivity as is ultimately forthcoming, and let us agree, consumers as well as producers should have consideration.

The national economy may *not* regard as essential any higher rate of production in a certain field, but it will always require that which is produced to be manufactured by efficient methods—by the economic use of scarce resources, particularly imported raw materials. Thus productivity and production are not necessarily the same thing.

This basic difference interests the Trade Union world too, largely because too many in management still think exclusively in terms of output, by volume.

The enquiring mind at work should take nothing for granted. Many industries use expensive raw material and think exclusively in terms of production. Even after full play has been given to work measurement in the normal sense, creating efficiency where there was inefficiency before; even then, there is a lot to be learned about human nature and how it reacts to opportunity. I know that financial incentives are not the whole story, but I am sure they are the main theme in the book.

Consider for a moment my own industry. There are two specialised departments which cut up expensive raw material, one the upper leather—the other bottom leather, into the essential shapes of a shoe. These cutters are pieceworkers by long tradition. The work lends itself to cash incentives. They work to a costing which varies with the type of shoe. The fear of the sack was regarded as a sufficient spur for economic use of material and the piecework price the incentive to output. By and large, the costing allowance has not altered over 50 years, except for style changes, and even the workers themselves would not believe they could improve their economic use of leather. It is estimated that the wages paid to these pieceworkers represent from 1/20th to 1/200th of the cost of the material they use and only through the introduction of work study has it been found that, fluctuating with the type of material, a 1% saving of material might equal a 20% increase in productivity. But apply to these departments only the normal incentive on production, and the average use of leather will not improve.

If, however, management faces up to the real relation of wage to cost of material and makes the inducement sufficiently high, the result in productivity including material saving will be quite astonishing.

This fact from my experience is quite a delicate one. It illustrates the importance of the human factor—the need for care to secure the best results, for, if the operatives with long experience do not know the main spring of their own actions or just do not believe that changed conditions will produce changed results, how can management expect to get optimum efficiency without regarding the human factor as important as technical efficiency?

The Danger of Imitation

We follow too closely now—or try to do so—the picture of the industrial scene we are told exists in the U.S.A. There is much to admire there, I agree, and we are grateful for their great co-operation and willingness to share their secrets, but we usually can develop our British way, and we can do so without chewing gum, driving on the wrong side of the road or eating with our fork in the right hand.

Take, for example, one of these cutting departments, bottom stock. The raw material is different from upper leather, in weight, in texture and method of cutting. It is cut on a heavy press, which by use of treadle and steel knife to shape 4" high, tapering off to a sharp cutting edge, is forced through the bend or belly on to a cutting board. There are in that department more men with fingers off than can be found in most industries. They are quite used to piecework, it is true, but investigations are proving that the cutting of this material economically produces greater economic results by making the basic incentive a material saving one and much safer to the operative. There is no direct incentive based on productivity as it is generally understood, although obviously the more leather used, the greater the potential saving—thus indirectly productivity counts too.

These few illustrations from my own industry are given, not to suggest their principles are for export to other industries—although they might well be—but only to emphasise that each of us must do our own thinking and not accept as inevitable in our search for maximum efficiency, methods adopted by other industries, without due regard to emphasis and variation, in the determination of which the skilled and knowledgeable craftsman and his Trade Union may have a substantial contribution to make.

Trade Unions and Work Study

In the shoe industry today, with work measurement principles becoming more rapidly established, we insist upon the incentive on output being accompanied by a scheme of material saving which is producing dividends for manufacturers, workers, and the community at large.

Motion study has a part to play also with regard to training in industry. Many workpeople and apprentices learn their jobs in the most haphazard and difficult way—in spite of, or perhaps because of, the trainer—and are not particularly efficient at the end of the training simply because no proper study has been made of the job.

It might be of interest to mention the work being done in my own industry on factors which cause or help some operatives to work faster than others. This is being carried out with the full support of my Union. What the industry has in mind is to discover faster methods of working which might be passed on to other workers. The connection between development such as this and the average pay packet, as well as the price of the product, is obvious. Moreover, it could lend to greater equality in performance and everyone knows that friction can be caused among workpeople by substantial differences in pay packets, whatever the reasons. Anything done to remove such frictions helps to create a happier working atmosphere besides pushing up efficiency and output.

On the whole, Trade Unions tend to regard motion and method study favourably and, together with

increased mechanisation and other industrial developments, see them as a source of a shorter working week, longer holidays and improved working conditions.

The very substantial change which has taken place in the attitude of Trade Unions to motion and method study has come to stay, but its encouragement is still essential. Management, generally, must forswear the narrow outlook which assumes that high earnings mean a worker is getting away with something. It is probably true to say that if the average wage was £15 or £20 per week, provided it represented a real effective performance, there would be no risk of an inflationary spiral. We are all concerned about the high cost of living, but it is because we are equally concerned at the cost of living high, the proper regarding of things in every-day use in most homes as necessities, which were luxuries 20 or 30 years ago, that we should remember that very high wages can mean a reduction in costs—if we put our producing house in order.

Trade Unions are increasingly recognising that time study, as a systematic approach to price fixing and work load assessment, can serve a useful purpose in industry, provided it is used honestly and that its limitations are appreciated. Trade Unions' opposition to time study will be greatest where management insists that the technique eliminates the need for collective bargaining, and that it provides a mathematically correct answer to wage and work load problems. I assume, in this connection, that there is no need to remind anyone of the subjective nature of rating or the arbitrariness often of allowances for fatigue and contingencies. I am not sure that fatigue is definable, let alone measurable, and yet some managements quote their percentage allowances as though they got them out of the Gospels!

In the circumstances, we feel that our views on what is reasonable compensation for rest and personal needs, based generally on long experience, are sound and well-formed: and on contingencies the operatives on the job will be no less knowledgeable than the time study engineer. All we demand is that there should be willingness to negotiate. I know one firm that includes, as appropriate, up to 5% allowance for loneliness.

The rating of operatives' performances comes in for more criticism from Trade Unionists than any other feature of work measurement principles, but by and large we like to see the result rather than reject rating on principle.

It is with regard to rating that we feel we have to be most careful as we are not happy about practices adopted by some specialists. No doubt as Trade Unions become more and more concerned with time study details, some awkward questions will be asked regarding concepts and standards of " normal " pace and the " operative of average ability." Those of us with more experience of these principles are certainly not seeking to have slack or loose values established, any more than we would willingly allow management to fix values which are too tight. What we look for is representative time, times for the job and not for the individual. We know that this may result in the conscientious worker with, perhaps, some special gift, earning high bonuses and this, we think, is as it should be.

A Matter of Principle

I myself have had one experience where time study slipped into one of the shoe factories without my being aware of it. I discovered it twelve months later, and on examining the wage cards, I was surprised to find that without the application of any scientific job valuation principle, the sort of wage average which I myself would have insisted upon was reflected in the earnings on several operations where the degree of skill was vastly different. On enquiring how this result was achieved without any agreement on the principle, I was informed that the manager informed the consultant that: " These are the girls you have got to take care of." Now it may be strange to some of you that although this method had produced the results for which I would have legislated, there is such a lack of principle about that kind of approach that my Trade Union and, I think, other Trade Unions would object on principle.

When we do agree on work measurement, we expect the values to be as correct as possible and the approved value from standard minutes to wages to be upon a correct basis, which will produce a result we would regard as fair and reasonable.

The All-Important Factor

In the introduction of these principles, we should remember that the human factor is all-important. We look for sincerity of intention from management. We look for the sanctity of contract, the sanctity of price and condition, thus emphasising again that management must do its job correctly in the first instance before the stop watch comes into play at all. In my industry and, I am sure, in other industries too, we certainly expect and obtain the opportunity of examining all relevant time study data, and we have no difficulty at all in getting the utmost co-operation from management and consequently from our own membership.

We, of course, introduce method and motion study for much wider purposes than setting the rate for the job: the livelihood of our members and their security of employment are tied up with the efficiency in any given plant, and we expect management to use, where practicable, the same scientific principles and apply them to market research, customer requirements and seasonal fluctuations, with a view to stabilising employment. We believe that, as a result, we will gain no less than management.

Problems will undoubtedly emerge, but with good relationships and good consultative machinery, it should not be beyond the wit of the two sides of industry to deal with them. It would be idle to pretend that all Trade Unions in Britain view improved management methods in this fashion, but it is certainly the direction of their thinking and very much progress has been made in the past few years. We take full cognisance of the fact that unless we do something about it, we have a limited ability to represent our members as effectively as they ought to be represented in discussions on time and motion study problems.

Most Unions today are taking steps to correct this situation. I cannot complain with regard to my industry as we believe we are perhaps a little ahead of the manufacturers in our knowledge of this subject.

Trade Union Training

At the present time well over five hundred Trade Union officials have attended the T.U.C. courses on production and management subjects. Other unions have organised specialised classes of up to one month's duration for hundreds of their officials and workshop representatives, so that a substantial percentage of Trade Union personnel have obtained at least an appreciation of scientific management. The T.U.C. has an arrangement with some firms of industrial consultants whereby Trade Union officials requiring more advanced training can obtain this " in the field " or at training centres over periods of two to four months, and this arrangement has proved most satisfactory. Many Unions, like my own, make arrangements with industrial consultants to this end.

We do not expect to produce in the Trade Union movement technical experts in the full sense of the term. Our object is that they should be able more effectively to represent their members and protect their interests with a better and improving understanding of management techniques. The Trade Unions are preparing to play a stronger role in industry; they are getting down to detail and for myself I believe this will result in a definite gain for industry and for the community.

We do not, ostrich-like, bury our heads in the sand as through our Scientific Advisory Committee, in which we have the willing co-operation of some eminent scientists, we can be as up-to-date as possible with the development in the peaceful use of atomic energy and the science of electronics. We play an equal part with the manufacturers' organisations and the British Productivity Council, and up and down the country our officers and our rank and file members are as active as any other group in the work of the local Productivity Committees. We preserve the close link with the Government and employers' organisations on the National Production Advisory Council of Industry, and the T.U.C.'s activities on that national body are conducted through our Production Committee, of which for the moment I happen to be the Chairman.

THE AUGUST ISSUE OF THE JOURNAL

will contain the following Papers presented to the Production Conference :

SESSION IV

" Simplification by Selection " by H. G. Conway, M.A., F.R.Ae.S., M.I.Mech.E., Chief Engineer, Short Brothers & Harland, Limited.

SESSION V

" Materials for Gas Turbines " by Dr. H. Sutton, C.B.E., D.Sc., F.R.Ae.S., F.I.M., Ministry of Supply.

SESSION VIII

" Introduction of Work Study into Smaller Firms " by H. G. Wood, M.A., B.Sc., M.I.W.M., Chief Work Study Officer, British Productivity Council.

SESSION IX

" Standards in the Electrical Exporting Industries " by D. Maxwell Buist, M.I.E.E., M.I.Ex., Export Director, B.E.A.M.A.

" Packaging and Movement " by R. E. Huffam, M.C., United Kingdom Co-ordinating Director, Unilever, Ltd.

" Work of the British Standards Institution as Affecting Export Trade " by H. A. R. Binney, C.B., Director, British Standards Institution.

SESSION X

" Human Factors in Technological Change " by Miss Beryl Foyle, Joint Managing Director, Boxfoldia, Ltd.

STANDARDISATION IN THE PROCESS INDUSTRIES

by E. W. GREENSMITH,

A.C.G.I., B.Sc., M.I.Mech.E.

Mr. Greensmith served his apprenticeship at the Royal Arsenal, Woolwich, and subsequently spent three years at the City and Guilds College, where he obtained the A.C.G.I. Diploma and a B.Sc.(Eng.) with first class honours.

After spending two years as a Lecturer at the Hull Municipal Technical College, he returned to the City and Guilds College as Demonstrator, for a further two years. In 1937 he joined Imperial Chemical Industries, Limited, as Technical Officer in the Research Department of the Alkali Division at Northwich, and was concerned primarily with research and development work on the polythene process. He was later appointed Head of the Engineering Division of this Research Department.

Mr. Greensmith was transferred to the I.C.I. Head Office in London in 1948, as Chief Inspecting Engineer, and in 1952, was promoted to his present appointment of Head of the Engineering Services Department.

Mr. E. W. Greensmith

IN general terms the process industries are concerned primarily with continuous processes for the manufacture of chemicals, although there are many cases where batch processes are used for the same purpose. These industries have for many years been engaged in large scale expansion programmes involving the expenditure of many millions of pounds on new construction work and, because of the nature of many of the processes, many millions are also spent annually on maintenance. It is the policy of most companies engaged in these process activities to buy as much as possible of the equipment required both for new construction and for maintenance from firms whose primary concern is engineering, and to make for themselves only a small part of the engineering equipment needed, this usually being of a special nature—for example, equipment which is being newly developed to keep pace with the demands and application of research. It is thought that similar considerations apply in the oil industry, which is, of course, branching out to an ever-increasing extent into the petroleum-chemical field.

Why Do We Standardise ?

Standardisation is accepted by most companies in these process industries and this acceptance is based on experience of the virtues derived from standardisation both during the construction of new plant and during its subsequent operation. It is true that in the chemical industry, as in the oil industry, research and development are going on continuously and call for advances in design, for replacement of plant and for better process control, but it is also true that there are several basic operations which are employed fairly commonly throughout these industries and for which standard components of good quality are economical because they facilitate design, procurement of equipment and erection of plant, and because the subsequent performance can often be predicted with reasonable certainty. Many firms have found from experience the benefits to be derived from the proper use of planned maintenance and have also found that interchangeable standard components are of great advantage in planning such maintenance to minimise stoppages in continuous processes, and to minimise expenditure on replacements, on stockholdings and on the supervision of repair work. Fig. 1 shows a good example of a company standard which has been developed to

FIG. 1

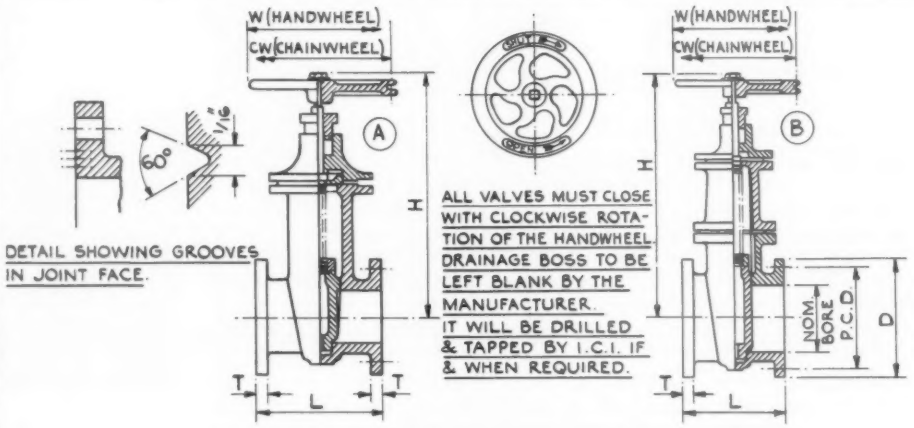
I.C.I. REFERENCE SECTION	I.C.I. REFERENCE NUMBER	VALVES, SLUICE, C.I. INT. SCREW (MED. TYPE) FOR LIQUOR & GAS. 1½"-24" BORE	I.C.I. REFERENCE SECTION	I.C.I. REFERENCE NUMBER
DA	1226		DA	1226

PAGE 1 OF 1

DIV. REF. DRG.	I.C.I. REF. DRG.	SPECN:- I.C.I. Nº A 157 C.	ISSUE No. 3 DATE APRIL 1954

GENERAL REFERENCES	
VALVES, SLUICE, C.I. INT. SCREW (LIGHT) GAS ONLY.	DA. 1245
" " " " " LIQ. & GAS.	DA. 1218
" " EXT. " " GAS ONLY.	DA. 1255
" " " " (MED.) LIQ. & GAS.	DA. 1210

BORE OF VALVE	MAX. WORKING PRESSURE LIQUOR	MAX. WORKING PRESSURE GAS	MAX. TEMP.	TEST PRESSURE HYDRAULIC	TEST PRESSURE ADD. AIR TEST FOR GAS VALVES
1½" - 12"	150 LB/SQ.IN.	50 LB/SQ.IN.	100° C.	300 LB/SQ.IN.	70 LB/SQ.IN.
14" - 24"	100 LB/SQ.IN.	35 LB/SQ.IN.	100° C.	200 LB/SQ.IN.	45 LB/SQ.IN.



DETAIL SHOWING GROOVES IN JOINT FACE.

ALL VALVES MUST CLOSE WITH CLOCKWISE ROTATION OF THE HANDWHEEL. DRAINAGE BOSS TO BE LEFT BLANK BY THE MANUFACTURER. IT WILL BE DRILLED & TAPPED BY I.C.I. IF & WHEN REQUIRED.

MATERIALS OF CONSTRUCTION			
BODY	CAST IRON	WEDGE	CAST IRON
COVER	CAST IRON	WEDGE NUT	CAST IRON
GLAND	CAST IRON	SPINDLE	MILD STEEL

ALL DIMENSIONS IN INCHES.

NOM. BORE	L	H MAX.	W MIN.	C.W. MIN.	FLANGES TO B.S. TABLE 'C'. D	T	BOLT HOLES Nº	DIA.	P.C.D.	APPROX WEIGHT LB.	CODE OR REF. Nº WITH H' WHEEL	WITH C' WHEEL
1½	7 1/8	13½	7	9	5¼	5/8	4	5/8	3 7/8	54		
2	8½	14½	7½	9	6	¾	4	¾	4½	63		
3	8½	17½	8	9	7¼	¾	4	¾	5¾	89		
4	8¾	20½	10	9	8½	⅞	4	¾	7	130		
5	10	23	10	12	10	⅞	8	¾	8¼	168		
6	11¼	24	12	15	11	⅞	8	¾	9¼	209		
8	13	28	13½	15	13¼	1	8	¾	11½	337		
9	13¾	31	15	18	14½	1	8	¾	12¾	386		
10	15	33	15	18	16	1	8	⅞	14	444		
12	17	39	16½	18	18	1⅛	12	⅞	16	634		
14	17¾	41	17	22	20¾	1¼	12	1	18½	887		
15	18	44	17	22	21¾	1¼	12	1	19½	968		
16	18	46	17	22	22¾	1¼	12	1	20½	1095		
18	19	49	19	28	25¼	1⅜	12	1	23	1446		
21	21	55	21	28	29	1½	16	1	26½	1953		
24	23½	60	24	36	32½	1⅝	16	1⅛	29¾	2597		

SUPPLIERS :- DRG. Nº 48144. 1½"-6" SK. (A) 8"-24" SK. (B)
FIG. Nº 2322. 2" SK. (A) 10" & 18"-24" SK. (B)
TYPE DRG. Nº 7547. 2" & 3" SK. (A) TYPE DRG. Nº 7548. 4"-12" SK. (B) TYPE DRG. Nº 7549 14"-24" SK. (B)

ISSUE Nº 2 APPROVED BY I.C.I. ENGINEERING STANDARDS SUB-COMMITTEE, SEPT. 1949.
ISSUE Nº 3 COVERING ALTERATIONS NOT REQUIRING COMMITTEE APPROVAL, APRIL 1954.

achieve most of the results outlined in the previous sentence. Valves of the type shown are used extensively in process factories and it is found that by specifying essential leading dimensions, including particularly the length over flanges, it is possible to run the plants efficiently as far as valve maintenance is concerned without keeping unduly large stocks of spares and without undue delay in carrying out maintenance work. It is to be noted that these advantages are achieved by specifying only essential dimensions and materials whilst leaving all detailed design to suppliers.

In addition to these fairly obvious advantages of standardisation there are certain others which are, in the Author's opinion, undoubted but which may not be so widely recognised. Some firms in the process industries have works situated in several parts of the country, some have central engineering design organisations, some have design offices at each works or group of works. Whatever the organisational arrangements for engineering research, design and maintenance may be, the saving in design time by using the knowledge of the most experienced designers to standardise components which are commonly used in one or more works can be very substantial. New engineers and draughtsmen joining the firms can, by consulting the standards documents, learn to apply in a shorter time than would otherwise be possible the design practices and operating procedures of the firms. It can be argued that a new draughtsman joining a company with a good standards organisation can be an effective member of the drawing office months earlier than he would be in the absence of such standards.

There is, unfortunately, a common assumption that standardisation necessarily results in stultification; the Author's opinion is that if a standards organisation is properly organised and if the practice of standardisation is really accepted in a company, this assumption is not only fallacious but is the reverse of the truth, because advances in knowledge in any branch of the company can quickly be turned to good account on behalf of the whole company. All that is necessary to achieve this happy state of affairs is to have, at all levels in the company, a proper appreciation of the benefits to be derived from a really progressive approach to standardisation. If these benefits are appreciated arrangements will be made for the establishment of an effective standards organisation of a scale appropriate to the needs of the firm, which will in turn lead to a constant review of everything that has been or can be standardised. This progressive approach to standardisation will also ensure that every standard is kept up to date and used, superseded by something better, or scrapped and will thus ensure that company practice is kept abreast of current developments. The foregoing outlines some reasons why those of us in the process industries are so much interested in standardisation.

What Do We Standardise ?

Having established why we standardise, let us now consider "What do we standardise?" In the company of which the Author has most knowledge standardisation can be divided, for the purpose of this Paper, broadly into five categories :—

1. British Standards. Each British Standard which is issued is examined to see if it is acceptable for adoption by the company. If it is acceptable, an Information Sheet is prepared stating briefly the scope of the British Standard and setting down ordering instructions so that the user of the Standard will know exactly how to frame his order using the material so specified. Equally, if the British Standard is not quite acceptable for company use, either because it is not sufficiently specific or because it is too restrictive, the Information Sheet will define how the British Standard is to be used by the company. The policy of the company being to simplify as far as possible, such simplification will be detailed in an Information Sheet where a British Standard gives a range of materials which is wider than we need and in a General Stores Standard Sheet (see 3 below) if the British Standard gives a range of sizes of items which is greater than we need. The Information Sheet copied in Appendix 1 shows a typical layout but is a very short, simple sheet chosen for ease of reproduction in this Paper.

FIG. 2

SPOONS
COFFEE & TEA.

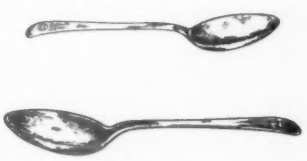
I.C.I. REFERENCE NO.

SECTION	NUMBER
SX	0502

REF. DRG. | SPECN :-

ISSUE NO. 1
DATE APRIL 1949

GENERAL REFERENCES	NO.
SPOONS,- DESSERT, SOUP, TABLE	SX 0500



THE I.C.I. ROUNDEL (I.C.I.) SHALL BE PERMANENTLY MARKED IN POSITION INDICATED.

QUALITY & FINISH :-
1.- E.P.N.S. "A" QUALITY.
2.- "STAYBRITE" STEEL.
3.- UNPLATED NICKEL SILVER WITH 20% MINIMUM NICKEL CONTENT.

QUALITY	I.C.I. CODE NOS TYPE	
	COFFEE	TEA
1		
2		
3		

APPROVED BY THE I.C.I. CATERING ADVISER.

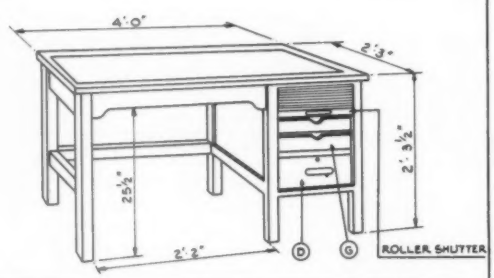
FIG. 3

OFFICE DESK No. 7

I.C.I. REFERENCE NO.:- SECTION SX NUMBER 1035

REF. DRG. | SPECN:- I.C.I. X.232 C. | ISSUE NO. 3 | DATE JUNE 1952

GENERAL REFERENCES	NO.
SEE BELOW	



DESCRIPTION		CODE OR REF NO WOOD TOP	CODE OR REF NO PLASTIC TOP
SINGLE R.H PEDESTAL FITTED WITH NEST OF FOUR STATIONERY TRAYS TYPE G SEE REF. SX 1041 FOR DETAILS SINGLE DRAWER TYPE D SEE REF. SX 1040 ALTERNATIVE PLASTIC TOP FOR TYPISTS USING HECTOGRAPHIC CARBONS			
TOP PANEL	FINISH		
"VYNIDE" QUALITY VG SHADE 8507 GRAIN 302	RECOMMENDED NATURAL OAK		
	ALSO AVAILABLE MEDIUM OAK		
	ALSO AVAILABLE DARK OAK		
SHADE 12436 GRAIN 302	MAHOGANY		

APPROVED BY I.C.I. OFFICE ADMINISTRATION DEPT. JUNE. 1952

APPROVED TYPE

2. Drawing Office Standards, which are prepared for use by engineers and draughtsmen in every drawing office in the company. Fig. 1 is a typical example of such a Drawing Office Standard, from which it will be seen that this type of document is prepared as an engineering drawing which can easily be understood by anyone familiar with drawing office practice and which can be used both for incorporation into the design of a complex plant and for issue to suppliers. In the company being quoted as an example there are in use 770 copies of the Drawing Office Standards book, each containing 1,279 sheets of the type shown in Fig. 1—incidentally these sheets are all dated 1947 or later, i.e. every one has been reviewed and reissued since 1947.

3. General Stores Standards. These documents are prepared in a form in which they can be understood by the most junior of storekeepers and cover a wide range of general stores ranging from teaspoons, Fig. 2, to typists' desks, Fig. 3; from files, Fig. 4, to fire hydrant fittings, Fig. 5. In our case there are in use 680 copies of the General Stores Standards book, each containing 480 standards sheets of which Figs. 2, 3, 4 and 5 are shown as examples.

4. Purchasing Specifications are company standards which are used as contractual documents for specifying the quality of material required by the company where no satisfactory British Standard exists. Appendix 2 shows a typical purchasing specification which is indeed the one quoted in Fig. 1. These materials specifications are under constant review and there are at present some 171 in force.

5. The fifth group will not be considered in detail in this Paper, except to mention that stationery, forms, office procedures, safety codes and regulations, accepted design data and many similar things and activities are standardised as far as possible throughout the company to reduce variations, anomalies and "paper work" to a minimum consistent with efficiency. It may be of interest to readers to know that at least one company in the process industry group is publishing a number of handbooks in which will be set down information based on experience in that company. These books will be on sale to the public through the usual channels and are being produced in the hope that experience gained in one company will be of value to the whole of British industry.

Having now reviewed why we standardise and what we standardise, it is appropriate to consider how we standardise.

FIG. 4

FILES
HAND AND WARDING.

I.C.I. REFERENCE NO.:- SECTION SR NUMBER 0103

REF. DRG. | SPECN:- B.S. 498 | ISSUE NO. 1 | DATE MAY 1949

GENERAL REFERENCES	NO.
FILES, ROUND, HALF-ROUND & SQUARE	SR. 0104
FILES, 3-SQUARE, TAPER-SAW & MILLSAW	SR. 0105

ALL DIMENSIONS IN INCHES

	HAND FILES NOMINAL LENGTH	WIDTH	THKNESS	I.C.I. CODE NO.	WARDING FILES NOMINAL LENGTH	WIDTH	THKNESS S.W.G.	I.C.I. CODE NO.
BASTARD CUT	6	23/32	11/64		4	15/32	18 G.	
	8	25/32	7/32		6	21/32	15 G.	
	10	1 5/32	17/64					
	12	1 9/32	5/16					
	14	1 15/32	23/64					
	16	1 21/32	15/32					
SECOND CUT	4	17/32	1/8		4	15/32	18 G.	
	6	23/32	11/64		6	21/32	15 G.	
	8	25/32	7/32					
	10	1 5/32	17/64					
	12	1 9/32	5/16					
	14	1 15/32	25/64					
SMOOTH CUT	6	23/32	11/64		4	15/32	18 G.	
	8	25/32	7/32		6	21/32	15 G.	
	10	1 5/32	17/64					
	12	1 15/32	5/16					
	14	1 15/32	23/64					
	16	1 21/32	15/32					

APPROVED BY I.C.I. ENGINEERING STANDARDS SUB-COMMITTEE, APRIL 1949

How Do We Standardise ?

The company to which reference is being specially made in this Paper has been built up by the amalgamation of a number of separate companies which have been welded into effective groups or Divisions. Each Division retains a large measure of autonomy, particularly in the engineering field. Standardisation has been accepted in most of these Divisions for many years, a fact which has to be kept constantly in mind when dealing with standards matters. Fig. 8 is included as a matter of historical interest because it shows the first known standards document produced in any of the constituent companies and it will be noted that this document dates from the 19th century —years before the British Standards Institution was founded. The accepted practice is that any items of equipment which are peculiar to one Division, and for which there is demand only within that one Division, will be standardised as Divisional standards or as provisional company standards. When there is sufficient interest in any item of equipment, a company standard can be formulated either on the basis of a Divisional or provisional standard or as an entirely new proposal. In spite of—or possibly because of—the common acceptance of company standardisation, the policy of the company is to use a national standard wherever one exists and is acceptable. In fact, whenever a national standard is issued by B.S.I. the appropriate authorities in the company review this British Standard to see whether it is of sufficient interest to the company to warrant its adoption in the company, even though this may involve the cancellation of an existing company standard. If the British Standard is adopted, an information sheet (as previously defined) is prepared and issued to all in the company who are concerned.

In view of the widespread interests of the process industries and of the many bodies which now concern themselves with standardisation both within and without the company, the organisation for really effective standardisation is necessarily somewhat complex. In these circumstances, there is an ever-present danger that the sheer complexity of the organisation will lead to inflexibility in its working. It follows that everyone convinced of the virtues both of standardisation and of the real necessity of keeping standards up to date must constantly concern himself with ensuring that the complexity of the organisation and of the issues involved is not allowed to stultify development and the implementation of standards. Figs. 6 and 7 are charts showing, in a necessarily simplified form, the organisation for standardisation in one of the major concerns in the process industries. The apparent complexity of this organisational chart is made necessary by what we believe to be a fundamental necessity—that is, that the " man on the job " —the user of the equipment—should preferably initiate the preparation of the standard, should co-operate in its preparation and should accept and use the standard when it has been agreed by everyone responsible.

The importance of the " man on the job " cannot be too strongly emphasised if standardisation is to be

FIG. 5

I.C.I. REFERENCE SECTION	NUMBER	HYDRANTS, FIRE, UNDERGROUND ADAPTORS "V" THREAD TYPE	I.C.I. REFERENCE SECTION	NUMBER
SX	3064		SX	3064

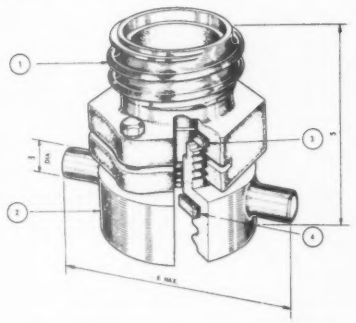
PAGE 1 OF 1

DIV. REF. DRG. | I.C.I. REF. DRG. | SPECN.:- | ISSUE No. 1 | DATE OCTOBER 1969

GENERAL REFERENCES
UNDERGROUND FIRE HYDRANTS DA 1190-4

MATERIAL:- WROUGHT PHOSPHOR BRONZE / CAST PHOSPHOR BRONZE OR ADMIRALTY GUN METAL

ALL DIMENSIONS IN INCHES



ITEM NO.	DESCRIPTION	CODE OR REF. NOS.
1	2½" "V" THREAD FEMALE TO 2½" ROUND THREAD MALE	
2	2½" "V" THREAD MALE TO 2½" ROUND THREAD FEMALE	
3	LEATHER WASHER (SMALL)	
4	LEATHER WASHER (LARGE)	

APPROVED BY I.C.I. ENGINEERING STANDARDS SUB-COMMITTEE, SEPTEMBER 1969

effectively used. Paper standards which are prepared and not used are more nuisance than they are worth and it is our submission that it is better to have a few standards which are widely used, than to have masses of paper which purport to present standards but which in fact merely remain as papers in a file.

Organise to use Knowledge of Specialists

Fig. 6 is an organisation chart showing the departmental and committee system established to co-ordinate company effort on many aspects of the business of the company. It also shows how a comparatively small staff, specialising on standardisation and suitably disposed throughout the company, can draw on the marginal resources of these several committees, each composed of experts in a given field. These resources are used to ensure that standards are based on the best information available both from our own company and from the makers of the equipment, to ensure that the standards are approved by a body competent to do so and to ensure that they are used effectively. The method of operation within this organisation will be discussed at greater length later.

Fig. 7 is a chart showing how the same resources are applied to—

(a) the appointment to B.S.I. and other technical committees of representatives who are sufficiently knowledgeable to make a real contribution to the deliberations of these committees;

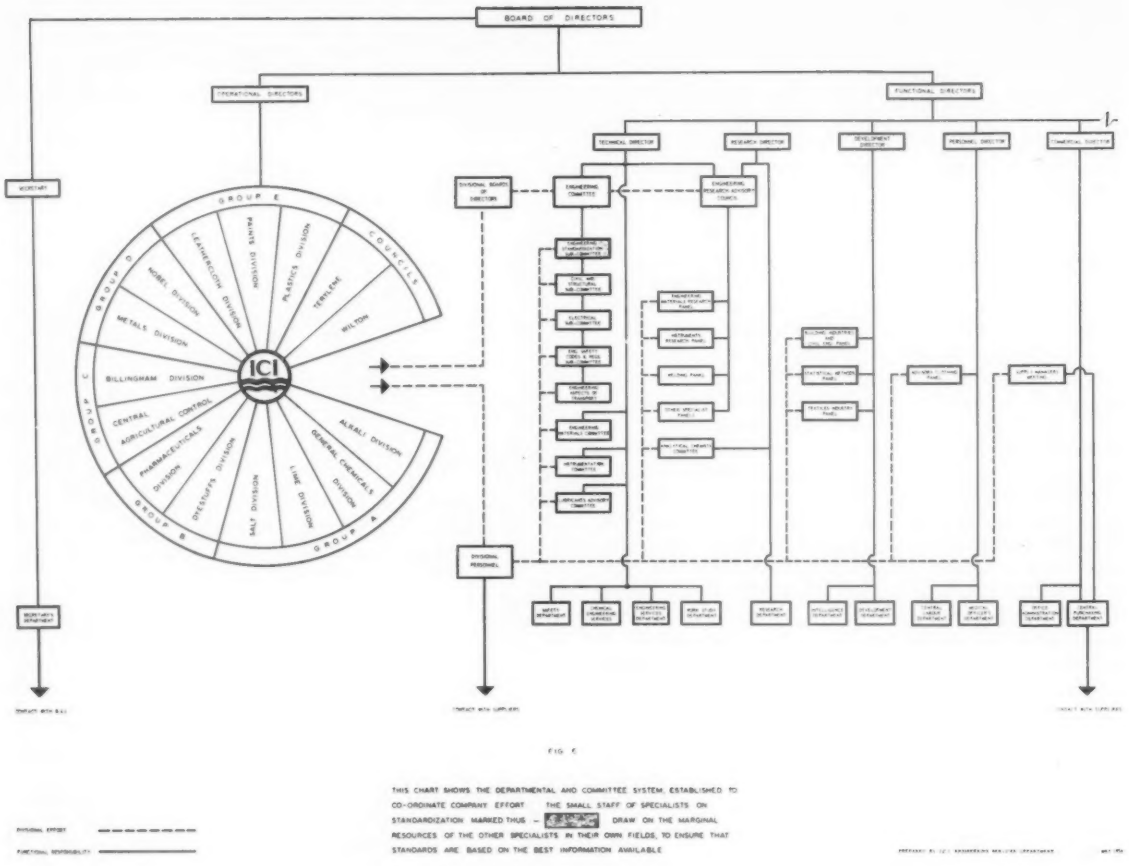


FIG. 5

THIS CHART SHOWS THE DEPARTMENTAL AND COMMITTEE SYSTEM, ESTABLISHED TO CO-ORDINATE COMPANY EFFORT. THE SMALL STAFF OF SPECIALISTS ON STANDARDIZATION MARKED THUS – [redacted] DRAW ON THE MARGINAL RESOURCES OF THE OTHER SPECIALISTS IN THEIR OWN FIELDS, TO ENSURE THAT STANDARDS ARE BASED ON THE BEST INFORMATION AVAILABLE

DIVISIONAL EFFORT ---------

FUNCTIONAL RESPONSIBILITY ———————

(b) the briefing of company representatives on B.S.I. and other committees concerned with standardisation, to ensure that the company view can be put forward on the firm foundation of company knowledge and experience;

(c) the adequate consideration of draft British Standards when they are circulated to industry for comment. Such consideration is given to all British Standards in which the company is interested, whether or not the company is represented on the drafting committee. When the company is represented, the collated comment is submitted to the representative before submission to B.S.I.;

(d) the proper assessment of British Standards with a view to their adoption by the company and also the preparation of the necessary supporting documents to ensure the proper use of such British Standards as are adopted. These supporting documents were mentioned in the paragraph numbered 1 on page 2.

It is considered that similar methods to those which have been developed for dealing with British Standards will enable us to give due consideration to the codes of practice and the recommendations which are being prepared by the International Standards Organisation, to both of which B.S.I. is devoting increasing effort.

It is assumed that it would not be entirely inappropriate in a Paper of this sort to suggest ways in which industry and B.S.I. could be enabled to work more effectively together. Experts in industrial concerns examine B.S.I. draft documents in which they are interested with great care and often spend much time in preparing comments, particularly on the final draft circulated for such industry comment. It would therefore clearly be very helpful when considering the adoption of newly issued British Standards if reference to the comments on the final draft was facilitated by the addition of the final draft number to the flyleaf of each Standard.

Organise to use Skill and Initiative

Organisations of this sort are efficient only if established routines, carefully thought out, are employed consistently to reduce to a minimum the effects of the fallibility of human memory, and

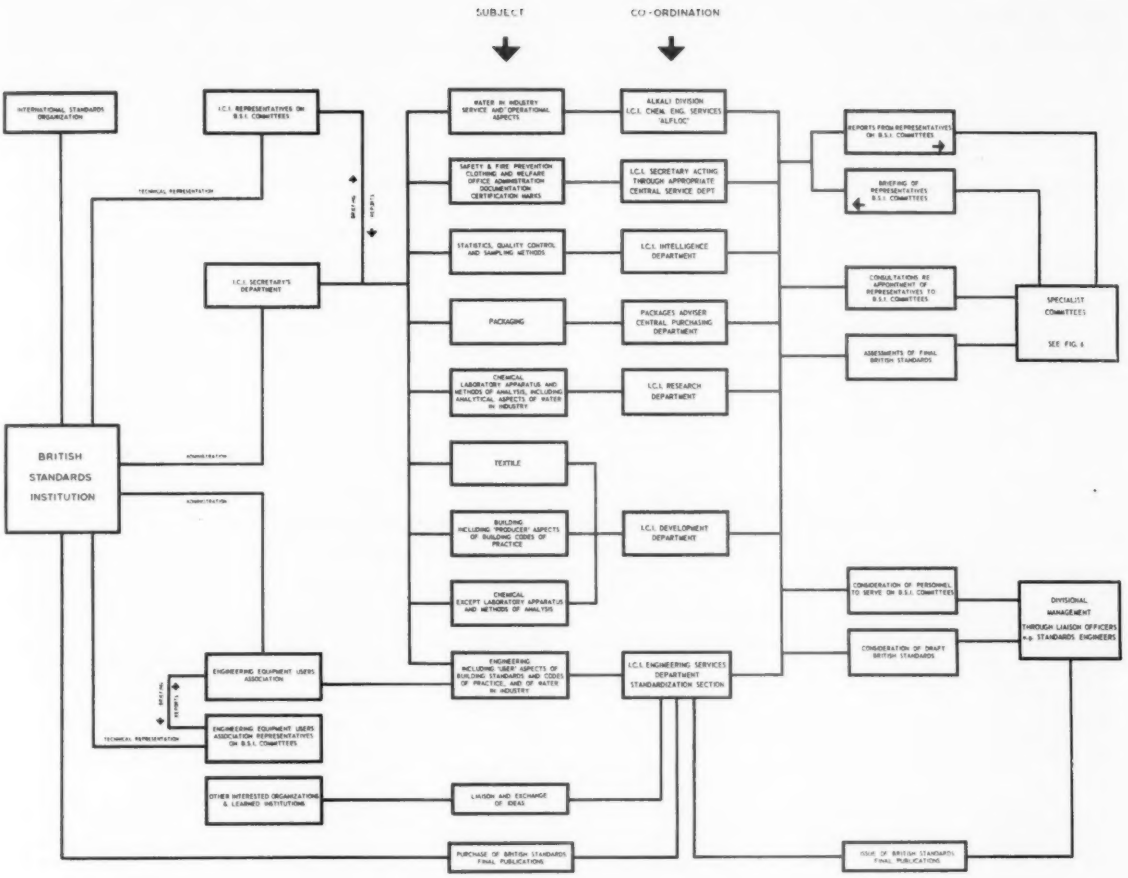

SUBJECT
CO-ORDINATION
INTERNATIONAL STANDARDS ORGANIZATION
I.C.I. REPRESENTATIVES ON B.S.I. COMMITTEES
TECHNICAL REPRESENTATION
BRIEFING
REPORTS
I.C.I. SECRETARY'S DEPARTMENT
BRITISH STANDARDS INSTITUTION
ADMINISTRATION
ENGINEERING EQUIPMENT USERS ASSOCIATION
ENGINEERING EQUIPMENT USERS ASSOCIATION REPRESENTATIVES ON B.S.I. COMMITTEES
OTHER INTERESTED ORGANIZATIONS & LEARNED INSTITUTIONS
WATER IN INDUSTRY SERVICE AND OPERATIONAL ASPECTS
SAFETY & FIRE PREVENTION CLOTHING AND WELFARE OFFICE ADMINISTRATION DOCUMENTATION CERTIFICATION MARKS
STATISTICS, QUALITY CONTROL AND SAMPLING METHODS
PACKAGING
CHEMICAL LABORATORY APPARATUS AND METHODS OF ANALYSIS, INCLUDING ANALYTICAL ASPECTS OF WATER IN INDUSTRY
TEXTILE
BUILDING INCLUDING PRODUCERS' ASPECTS OF BUILDING CODES OF PRACTICE
CHEMICAL EXCEPT LABORATORY APPARATUS AND METHODS OF ANALYSIS
ENGINEERING INCLUDING USERS' ASPECTS OF BUILDING STANDARDS AND CODES OF PRACTICE, AND OF WATER IN INDUSTRY
LIAISON AND EXCHANGE OF IDEAS
PURCHASE OF BRITISH STANDARDS FINAL PUBLICATIONS
ALKALI DIVISION I.C.I. CHEM. ENG. SERVICES 'ALFLOC'
I.C.I. SECRETARY ACTING THROUGH APPROPRIATE CENTRAL SERVICE DEPT.
I.C.I. INTELLIGENCE DEPARTMENT
PACKAGES ADVISER CENTRAL PURCHASING DEPARTMENT
I.C.I. RESEARCH DEPARTMENT
I.C.I. DEVELOPMENT DEPARTMENT
I.C.I. ENGINEERING SERVICES DEPARTMENT STANDARDIZATION SECTION
REPORTS FROM REPRESENTATIVES ON B.S.I. COMMITTEES
BRIEFING OF REPRESENTATIVES B.S.I. COMMITTEES
CONSULTATIONS RE APPOINTMENT OF REPRESENTATIVES TO B.S.I. COMMITTEES
ASSESSMENTS OF FINAL BRITISH STANDARDS
SPECIALIST COMMITTEES
SEE FIG. 6
CONSIDERATION OF PERSONNEL TO SERVE ON B.S.I. COMMITTEES
CONSIDERATION OF DRAFT BRITISH STANDARDS
DIVISIONAL MANAGEMENT THROUGH LIAISON OFFICERS e.g. STANDARDS ENGINEERS
ISSUE OF BRITISH STANDARDS FINAL PUBLICATIONS

FIG. 7.

CHART SHOWING ORGANIZATION USED FOR LIAISON ON STANDARDIZATION

framed so as to use for each step in the routine persons who are no more highly skilled than they need be for the efficient conduct of that step. It is considered important that the routine shall be so laid down that skilled technical members of the staff are not required to carry out operations which can be done effectively by the non-technical staff. Great skill and thought may be employed in developing the simplest possible routine to achieve efficiency by ensuring that each step in the process follows logically after the other, involves no more effort than is necessary but does not remove the opportunity to use skill and initiative at the stages where skill and initiative can properly be employed.

Organise Effective Collection of Information

Much of the work in the preparation of standards involves drawing office and clerical effort. It is our experience that such effort is most effective when it is assisted by the employment of forms designed for the purpose. These forms are particularly necessary when information has to be collected from a number of sources and made available to the right people in the right place at the right time, so that duplication of effort is eliminated as far as possible and so that the final documents present the standard in the desired form and ensure that it is properly reviewed.

Appendix 3 contains a representative sample of the forms which have been developed to facilitate the standardisation procedures and it is hoped that the inclusion of these forms may be helpful to others. Form (Standards) 1 is used for initiating either a new standard or a revision of an existing standard. It will be noticed that this form is sent by the Divisional Standards Engineer to the Head Office Standards Section but it must be made clear that the Standards Engineer does himself collect suggestions from members of the staff of the Division which he serves.

The suggestion for this initiation may indeed come from any member of the staff and by being passed through established channels is sure to have due consideration. Everything possible is done to ensure that suggestions are considered and acted upon as speedily as possible.

When a Form (Standards) 1 from one Divisional Standards Engineer is received at Head Office, Forms (Standards) 2 are circulated to all other Divisional Standards Engineers so that the views of all Divisions can be obtained on the proposal. It will be seen that the completion of this form is not very time-consuming for one such as a Standards Engineer, familiar with Divisional requirements and particularly with his colleagues' views on standards generally. It will also be seen that whereas a formal reply can be given simply, provision is also made for the submission of supplementary information if any Standards Engineer feels that he has a special contribution to make at this early stage. Form (Standards) 3 is used to tell all Divisional Standards Engineers the sense of the replies received from all Divisions on Form (Standards) 2 and to indicate how it is proposed that the work be undertaken. It will also be seen that seven days only are allowed for entering objection to these proposals and that in the absence of such objection within that period the work is put in hand.

Immediately the decision is taken to proceed with the preparation of the standard, the job is entered on a Programme and on a Progress Form—Form (Standards) 7 (see opposite page), which is used not only to record but also to control the movement of the draft standard and to record the responsibility of an individual for each stage in the procedure.

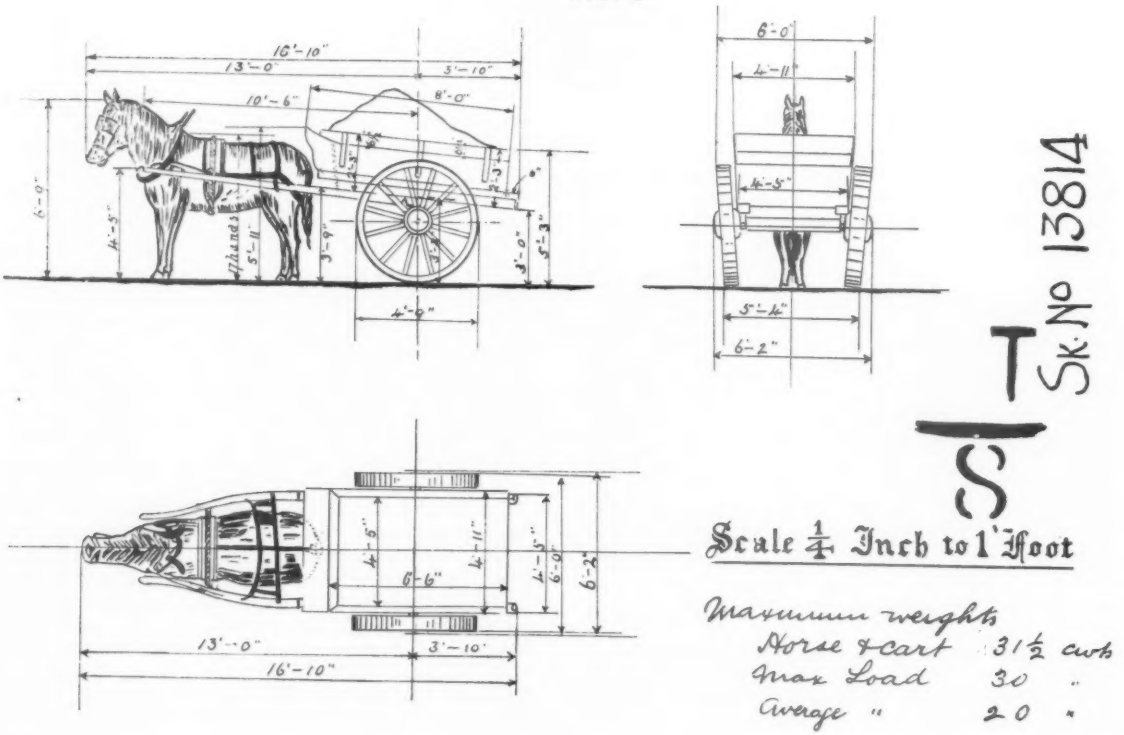
It is a strictly observed rule that no one may accept papers from the previous user without being satisfied that the previous person has signed and dated the Progress Form, thus indicating that everything to date is considered satisfactory.

All work in progress is reviewed periodically by the Head of the Standards Section and any delay in the progress of any job is readily noted from the dates on the Progress Form, the reasons for such delay are examined and arrangements made as soon as possible to eliminate the causes of the delay and thus speed the work to a proper conclusion.

Effects Resulting from New or Revised Standards

The effect of alterations to and cancellations of existing specifications and standards can be just as important as the effect of the introduction of new standards. It is, however, not sufficient simply to note

FIG. 8



new standards or changes — action called for by any such change has to be taken. Such action applies particularly in connection with the purchasing of equipment and for this reason close liaison is maintained between the standards engineers and the purchasing organisation. Cross-referenced indexes are kept relating contracts and specifications and standards, so that each time a contract is renewed the use of the latest specifications and standards is confirmed and so that each time an addition or alteration is made to the specifications and standards, due note of such alteration can be made in the relevant contracts.

Organise User Interest

The virtues of joint consultation and common approach to standardisation are well appreciated by many of us in the process industries. Moreover something effective is being done to take advantage of these virtues. These companies have extensive experience in the use of a wide range of equipment under many conditions and in many places. It was thought that it would be helpful to the British Standards Institution if a group of users such as this collaborated in, or even promoted, the preparation of standards specifications for such materials and general stores as are commonly used. The Engineering Equipment Users Association was formed in 1950 as an association of several major companies in the process industry, so that ideas could be exchanged and agreement could be reached on a common approach to standardisation. Careful thought is given to the selection of the representatives of the Association on B.S.I. committees. These representatives are well briefed, are empowered to negotiate, provided an acceptable compromise is attainable, and are able to refer back to the Association for guidance when required. It is already evident that not only the Association, but the B.S.I. committees—and hence the industry as a whole—is deriving considerable benefit from the effectiveness of this user representation on B.S.I. committees.

More recently, a joint committee on standardisation has been set up by the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers Association. Here manufacturers and users of equipment discuss common

FORM (STANDARDS) 7

PROGRESS FORM

for

I.C.I. SPECIFICATIONS & INFORMATION SHEETS.

CONVERT FROM EXISTING DOCUMENT (TO BE CANCELLED)		TO	NEW DOCUMENT (TO BE ISSUED)	
Specn. No. Inf.Sheet No.	Date Date		Specn. No. Inf.Sheet No.	Date. Date.
Pages Nos. Fig. Nos.			Pages Nos. Fig. Nos.	

FUNCTION	ACTION	SIGNED	DATE COMPLETED	ENTERED ON KARDEX SIGNED
CLERICAL	I.C.I. Ref. No. Allocated			
	New Card entered in Index.			
TECHNICAL	AUTHORISED BY COMMITTEE MINUTE			STAGE 9
	FINAL DRAFT PREPARED			
	PROTOTYPE ATTACHED INDICATING MINOR ALTERATIONS.			
	REFERENCES TO OTHER DOCUMENTS ENTERED (SEE OTHER SIDE)			
	CIRCULAR (STDS) RAISED			
CLERICAL PROGRESS	NEW DIAPOSITIVES PREPARED — or —			STAGE 10
	EXISTING DIAPOSITIVES ALTERED — or —			
	EXISTING DIAPOSITIVES CANCELLED			
	CHECKED			
TRACING (SKETCHES)	NEW TRACING PREPARED — or —			
	EXISTING TRACING ALTERED — or —			
	EXISTING TRACING CANCELLED			
	CHECKED			
ENGINEER	APPROVAL FOR PRINTING & ISSUE			STAGE 11
PRINTING	EXISTING NEGATIVE(S) CANCELLED			
	EXISTING PLATE(S) CANCELLED			
	NEW NEGATIVE(S) PREPARED			
	NEW PLATE(S) PREPARED			
CLERICAL	NEW COPIES CIRCULATED (CIR.NO.)			STAGE 12
	EXISTING STOCK CANCELLED			
	MASTER BOOK CORRECTED			
	INDEX CARDS (INC.THOSE REFERRED TO ON OTHER SIDE) BROUGHT UP TO DATE			
	FORM (STDS) 4 RAISED			
	FORM (STDS) 6 RAISED			

T = Tracing
D = Diapositive
N = Film Neg.
R = Rotaprint Plate.

Circulation

SUBJECT NO.
CORR. FILE NO.
PRINT REQN NO.

REASON FOR REVISION:

NOTES:

.....

THIS INFORMATION TO BE COMPLETED BY D.O.

SECTION FOR I.C.I. MASTERS ONLY.

Reference made on Document to:-

D.O. Standards	Stores Standards	I.C.I. Specs.	B.S. Specs.

Other Documents:

.....

.....

.....

Signature.....

problems and the possibility of a common approach to standardisation, whether it be through B.S.I. or through agreed company standards. The virtues of user interest in standardisation having been advocated for so long and having been demonstrated so effectively, it is to be hoped that many more users of materials and equipment that can helpfully be standardised will take an active part in the work of B.S.I. and thus help the productive efficiency of industry as a whole.

Current Developments

Great advances have been made in the process industries, as in other industries, in the application of Work Study. The methods employed in Work Study can properly be used in selecting some types of equipment for standardisation. There is evident need for collaboration between the Standards Engineer and the Work Study Engineer when either is concerned with a problem of mutual interest. It is, for example, obviously desirable to consult the Work Study Engineer if the Standards Engineer is considering standardising tools commonly used in a factory. It is equally clear that if the Work Study Engineer is studying operations involving the use of commonly used equipment, he should consult the Standards Engineer with a view to getting desirable equipment standardised throughout the company.

Floor-sweeping is one of the simpler and more common operations in many factories. Work Study can be used to make the sweeper more effective at his job and in order to make it possible for the man to maintain his improved efficiency, standardised sweeping brushes must be provided. The standard brushes must not only be of the good quality that is conventionally standardised, but must also be of the optimum size for effective working. These optimum sizes are now being determined by Work Study methods.

Similar studies are being carried out in connection with floor-polishing, which is quite an expensive process in large blocks of offices, on hacksawing, where studies are being made on those of the hacksaw blades in B.S. 1919/1953 which have been adopted as company standards, and on welding, an operation which looms very large in process factory construction and maintenance.

Many people work at desks and tables and we have therefore prepared standards in collaboration with our principal suppliers. These standards are constantly reviewed to make sure that they take advantage of new manufacturing techniques and of changes in methods of working suggested by work study, which is of course applied to clerical operations. Comparatively small changes made in 1952 to our specifications facilitated manufacture and resulted in a saving of some thousands of pounds. More recently, Work Study carried out on typists has led to changes in design of the desk to reduce the effort expended by the typist in carrying out her duties efficiently. It is perhaps not entirely a coincidence that a new design evolved to improve efficiency is also likely to cost considerably less than the previous type of desk which was itself thought to be an effective design.

It is naturally hoped that Work Study will confirm that the standards that have been based on common usage will stand up to this further analysis, but changes will be made if it is shown that such changes will lead to increased productivity.

We realise that these may appear to be simple studies, but in the absence of any previous experience we have to learn the hard way and we hope that great advances will be based on a sound foundation of factual evidence.

Conclusion

The emphasis in this Paper has been on how to standardise, in the hope that most readers will already have been converted to the idea that real economies can be made through standardisation of equipment, and may therefore be helped in their efforts to standardise by seeing how the problem has been tackled with some success in a big company. It is the Author's view that the time for vague generalisations has gone, the time when we could leave standardisation to the other man has gone; the time has arrived when everyone in industry must use to the limit standardisation as a means to increase production.

Acknowledgments

The author thanks the Directors of Imperial Chemical Industries Limited for permission to submit this Paper and thanks his colleague, Mr. A. Parrish, A.M.I.Mech.E., without whose help the Paper would not have been possible.

The Appendices referred to in the above Paper appear on pages 415-420.

APPENDIX 1

I.C.I. Information Sheet No. M.429
No. of Pages: 2

IMPERIAL CHEMICAL INDUSTRIES LIMITED

The following notes are for I.C.I. use only and are to be used when specifying, ordering or enquiring for materials to the British Standard Specification referred to below:—

60 : 40 BRASS RODS, SECTIONS AND FORGINGS
(For General Engineering Purposes)
to
B.S. 1949 : 1953

General Notes

The original request for a standard covering 60/40 brass sections came from pressure vessel makers and this general purpose standard incorporates the special requirements of that industry. The specification provides for rods, sections and forgings and two grades of material are specified. Grade A is a high purity alloy containing 0.1% max. of lead, and is intended for applications for which maximum ductility is required. Grade B, on the other hand, is of normal commercial quality and may contain up to 0.75% of lead.

Rods and Sections (see Clause 7)

Minimum Ultimate Tensile Stress	—	20–22 tons/sq. in. according to cross-sectional dimensions.
Minimum Elongation	—	30%.

Forgings (see Clause 12)

Minimum Ultimate Tensile Stress	—	20 tons/sq. in.
Minimum Elongation	—	30%.

Related Specifications

B.S.264—Hot rolled yellow metal plates, sheet and strip.

Ordering Procedure

1. Quote B.S.1949.
2. (a) For rods give details of the cross-sectional profile and length required. Specify hexagons by the decimal sizes across flats and not by the B.S.W., B.S.F., U.N.C., U.N.F. or B.A. sizes.
   (b) For forgings, detailed dimensions (preferably on a drawing) should be given. Machined surfaces should be clearly indicated so that the rough forging can be left oversize as appropriate. The order should state whether unmachined, rough machined or fully machined forgings are required and in the case of rough machined forgings indicate how much material should be left for final machining. (See Clause 10.)
3. If the manufacturer is required to provide a copy of his works analysis of the material this must be stated. (See Clause 2.)
4. If the material is required in the fully annealed condition this must be stated. (See Clause 3.)
5. (a) For round, square or hexagon rods state the dimensional tolerances required extracted from the relevant column in Table 1, 2 or 3. (See Clause 5.)
   (b) For all other items the dimensional tolerances to be applied should be stated after discussion with the manufacturers. (See Clause 5.)
6. If bend tests are required this must be stated. (See Clause 7b.)
7. If the material is to be subject to inspection by the Company's Inspecting Engineer at the Maker's Works, this must be stated. (See Clause 14.)
8. If a certificate of compliance is required this must be stated indicating the number of copies required. (See Clause 14.)
9. Any special packing and marking instructions should be stated, but in all cases the Company's minimum requirements should be specified, i.e. all materials shall be packed so as to prevent damage or corrosion in transit, and each consignment shall be clearly marked with the appropriate order number.

March, 1954.

APPENDIX 2

I.C.I. Specification No. A.157C

SPECIFICATION
for
CAST IRON SLUICE VALVES FOR CHEMICAL LIQUORS AND LOW TEMPERATURE GAS
(This cancels and supersedes I.C.I. Specification No. A.157B dated October, 1949)
IMPERIAL CHEMICAL INDUSTRIES LIMITED

February, 1954.

I.C.I. Specification No. A.157C

ORDERING INSTRUCTIONS

The following notes are for I.C.I. Office use only, and do not form part of the Specification.

When ordering, attention must be given to the following:—

(a) Size and type of valve quoting the appropriate I.C.I. Standards Sheet Number. (See Note below.)
(b) State whether flanges are to be left undrilled.
(c) If chainwheel is required, give dimension from centre of wheel to floor or platform. If floor column is required, give dimension from centre of valve bore to base of floor column.
(d) Whether cap, surface box or protecting tube is required. (See I.C.I. Standards Sheet DA.0270.)
(e) If jointing and packing must be other than that required by Clause 13, this should be fully specified.
(f) State if air test or any other special test is required, and state the test pressure for the valve face tests where this is intended to be different from that quoted in Clause 14.
(g) State whether body or cover shall be painted or left as cast, as an alternative to the requirements of Clause 16.

NOTE: The following I.C.I. Standards Sheets are identified with this specification:—

Liquor or Gas Int. Screw	DA.1226
Light Patt. for Gas Int. Screw	DA.1245

Small Light Patt. for Gas and Liquor Int. Screw	DA.1218
Light Patt. for Gas Ext. Screw	DA.1255
Liquor or Gas Ext. Screw	DA.1210

I.C.I. Specification No. A.157C
No. of Pages: 6

SPECIFICATION
for
CAST IRON SLUICE VALVES FOR CHEMICAL LIQUORS AND LOW TEMPERATURE GAS

(This specification cancels and replaces I.C.I. Specification No. A.157B dated October, 1949)

To the order of Imperial Chemical Industries Limited, or a subsidiary company of Imperial Chemical Industries, which hereinafter will be referred to as " the Company ".

This document, the copyright of which is the property of Imperial Chemical Industries Limited, must be used only for an enquiry or order from Imperial Chemical Industries Limited, or a subsidiary company thereof, and must be promptly returned to them upon completion of the enquiry, tender or order. The document must not be copied wholly or in part without permission in writing from:—

Imperial Chemical Industries Limited,
Engineering Services Department,
Standards Section,
Imperial Chemical House,
Millbank, London, S.W.1.

Where permission is granted no charge will be made, but Imperial Chemical Industries Limited reserve the right to impose restriction on the use of this specification where necessary. Imperial Chemical Industries Limited cannot accept liability for the use of this specification when such permission has been given, nor undertake to notify the user of any alteration to it.

1. **General**

Valves shall be of the " wedgegate " type with internal or external screws, and shall be of British material and manufacture throughout and shall conform to the dimensions and material specification given on I.C.I. Standards Sheets DA.1226, DA.1245, DA.1218, DA.1255 and DA.1210 according to the Company's Order, and shall be suitable for the maximum working conditions of temperature and pressure thereon stated. The design of the valves shall be such that they may be operated in the vertical or horizontal, or any intermediate position.

2. **Materials**

(a) All iron castings shall conform as a minimum requirement to B.S.1452 Grade 12. Castings shall not be filled, burnt up or repaired in any way. Chaplets, when found necessary, shall be of turned cast iron to the same specification as that of the parent metal and of such section as to be readily fusible with the main casting.

(b) All components specified as being made of mild steel shall conform to B.S.15 No. 1 quality.

(c) Material for the nut in the case of external screw type valves only, shall be of hard cast gun-metal or phosphor bronze having a Diamond Pyramid Hardness of 80 to 90.

3. **Body and Cover**

The body and cover shall be of sound clean cast iron of even section, designed to withstand the hydraulic tests called for on the I.C.I. Standards Sheet quoted in the Company's Order. They shall be accurately machined and fitted throughout. The stuffing box shall be of a depth adequate to accommodate sufficient packing to suit the service conditions.

The body shall have guides provided on both sides to engage with corresponding guides in the wedge.

The cover shall be attached to the body by bolts. Studs or tap bolts shall not be used unless agreed in writing by the Company.

For valves with external screws, bosses shall be provided on the cover casting to form seatings for the base of the mild steel columns supporting the bridge.

4. **Wedge**

The wedge shall be of cast iron, made in one piece, accurately machined on both faces to suit the corresponding machined faces on the inside of the valve body. It shall be tried in place and finished in a manner best suited to the Contractor to ensure a perfect drop tight bearing. Guides cast integral with the wedge shall be provided to engage with guides in the body casting.

5. **Spindle and Nut**

The valve spindle shall be of forged mild steel (see Clause 2b) machined all over. The thread shall be a machine-cut square thread of sufficient length to allow the wedge to be raised to a position giving a full-flow clear passage.

For internal screw valves a thrust collar shall be formed integral with the spindle, and this collar shall engage with machined thrust surfaces on both sides. The spindle end shall be squared for a cast iron cap or squared and tapped for handwheel attachment.

Internal screw valves shall be provided with a cast iron wedge nut. (See Clause 2a.)

External screw valves shall have a gun-metal or phosphor bronze nut (see Clause 2c) keyed into and locked to the handwheel.

6. **Flanges**

The dimensions, drilling and grooving of flanges shall be in accordance with the I.C.I. Standards Sheet quoted in the Company's Order, and flanges shall be machined across full face. Flanges shall be finished square with the axis of the valve. Holes shall be drilled to template off centres, and be within the following limits of accuracy:—

Plus or minus 1/32" on P.C.D.

P.C.D. to be concentric with flange and bore to within 1/16".

7. **Pillars and Bridge: (External Screw Valves, I.C.I. Standard Sheets DA.1210 and DA.1255)**

The pillars shall be of mild steel. (See Clause 2b.)

The bottom end of each pillar shall be shouldered and screwed into the bosses provided on the valve cover, or secured by nut through the cover and body flanges. The top end of each pillar shall be shouldered and screwed to take the bridge. For valves to I.C.I. Standards Sheet DA.1255 the bridge shall be of cast iron. (See Clause 2a.) For valves to I.C.I. Standards Sheet DA.1210 the bridge shall be of cast iron, or forged steel. (See Clause 2b.) In

all cases the bridge shall be accurately bored to take the gun-metal or phosphor bronze nut. An oil hole shall be provided for lubrication of the nut, spindle and bridge bearing.

8. **Handwheel**

All valves, unless specified otherwise in the Company's Order, shall close with a clock-wise rotation of the hand-wheel. A cast iron handwheel of "cast finish" shall be fitted and shall have cast on the upper side of the rim the words "OPEN" and "SHUT" with the appropriate direction arrows. The diameter of the handwheel and the lettering and arrows shall be in accordance with the I.C.I. Standards Sheet quoted in the Company's Order. The handwheel for internal screw valves shall be secured to the valve spindle by a steel set screw. A steel washer shall be fitted between the head of the set-screw and the handwheel boss.

For external screw valves, the handwheel shall be bored and keywayed to suit the gun-metal or phosphor bronze nut. Where specified in the Company's Order, valves shall be fitted with a chainwheel instead of the handwheel. The chainwheel diameter shall be in accordance with the I.C.I. Standards Sheet quoted in the Company's Order and in all cases the wheel shall be provided with an approved type of guard or keeper to prevent the chain riding off the wheel.

9. **Gland**

The gland shall be of cast iron, machined to suit the stuffing box, and smooth bored to suit the spindle. Tee-headed bolts shall be provided for tightening the gland. Studs shall not be used.

10. **Bolts, Nuts and Setscrews**

Bolts shall be of black mild steel to I.C.I. Specification D.178C, screwed British Standard Whitworth (B.S.W.)

11. **Floor Column for Extension Spindles**

A cast iron floor column in accordance with I.C.I. Standards Sheet DA.0310, fitted with an indicator of approved pattern, shall be supplied when specified in the Company's Order.

12. **Cap and Surface Box**

When specified in the Company's Order a cast iron cap shall be provided in accordance with I.C.I. Standards Sheet D.A.0270. This sheet also specifies dimensions for Surface Boxes and Protecting Tubes when required.

13. **Jointing and Stuffing Box Packing**

Unless otherwise specified the body and cover joints shall be made with india rubber jointing in accordance with I.C.I. Specification M.228B. The stuffing box shall be packed with greased and graphited asbestos packing.

14. **Testing**

Each valve shall be subjected to three separate hydraulic tests as follows, carried out in the order given:—

(a) ***Valve Body Test***

With both flanges suitably closed, and with the wedge in the "fully open" position, the full hydraulic test pressure specified on the I.C.I. Standards Sheet quoted in the Company's order shall be applied to the body of the valve.

(b) ***Valve Face Tests***

Two "open-end" tests shall be made to determine the water-tightness of the valve faces. Each end of the valve shall in turn be closed, with the other end left open, the wedge in the "closed" position and the body free to expand. A hydraulic test pressure equal to $1\frac{1}{2}$ times the working pressure stated on the Standards Sheet or as may be quoted in the Company's order, shall be applied to each closed end.

Each test shall be held for a reasonable period and any signs of porosity or leakage, or failure of materials under test, shall provide grounds for rejection of the valve.

In addition, where required by the Company's Order, valves shall be tested by air to the pressure specified. In this test, the valve shall be laid on one flange with the wedge closed. The upper branch of the valve above the gate shall be filled with water, and air pressure applied to the lower branch below the wedge. During this test, air bubbles shall not be evident. The valve shall then be reversed and the other side tested in the same manner.

Valves satisfactorily passing the tests shall be stamped on the upper edge of one flange with "I.C.I. Ref. DA.1226, DA.1245, DA.1218, DA.1255 or DA.1210 whichever shall be quoted in the Company's order.

In the case of gas valves which shall have been air tested, they shall be stamped on the upper edge of one flange, for example, as follows:—"I.C.I. Ref. DA.1245 (Air Tested)".

The Contractor shall supply, at his own expense, all the labour and facilities necessary for carrying out the above tests and shall supply test certificates, in duplicate, to the Company.

15. **Inspection**

The Company's Inspecting Engineer shall have free access to the Works of the Contractor at all reasonable times to examine the valve at any stage during its manufacture, to witness tests, and to reject any material which does not conform to this specification.

16. **Coating**

The body and cover of each valve shall, after passing the tests, be thoroughly cleaned and wire brushed. Unless otherwise specified they shall afterwards be coated externally only with an approved bituminous solution giving a smooth hard surface when set.

17. **Marking and Packing**

Valve bodies shall be marked with cast-on or stamped lettering giving the maker's name or trade mark and the size of valve. In addition all valves shall have a metal label wired on, bearing the Company's Order Number, together with any other identification marking which may be specified in the Company's Order. The Contractor shall ensure that all valves are properly stacked in the wagon before despatch from his Works and any part of any valve damaged in transit shall be immediately replaced free of cost to the Company.

February, 1954.

APPENDIX 3

IMPERIAL CHEMICAL INDUSTRIES LIMITED

FORM (STANDARDS) 1

SUBJECT NO.....
(This number will be allocated by Standards Section, Engineering Services Department.)

This form is to be used in initiating or revising I.C.I. Standards. The technical data on this form are not intended to be comprehensive but give a brief description of the subject matter.
For Electrical Standards use Form (Standards) 1 (L)
For Safety Standards use Form (Standards) 1 (X)

From: Standards Engineer,
Imperial Chemical Industries Limited,

.....Division.

To: Imperial Chemical Industries Ltd.,
Standards Section,
Engineering Services Department,
24/30, Gillingham Street,
LONDON, S.W.1.

Date.....

(a) A revision of the following I.C.I. Standard* is recommended

Standards Reference No. .....

REASONS.....

.....

.....

(b) The initiation of the following I.C.I. Standards* is recommended

Subject .....

Description .....

Material .....

Specification No......

Reference Drawings .....

Comments in support of proposal.....

.....

.....

The following headings should be completed for the guidance of the Standards Section, Engineering Services Department.

*SUGGESTED CLASSIFICATION:
(a) I.C.I. General Stores Standard
(b) I.C.I. Drawing Office Standard
(c) Divisional Standard
(d) I.C.I. Specification
(e) I.C.I. Information Sheet based on B.S.

DELETE WHERE INAPPLICABLE

SUGGESTED ALLOCATION OF WORK:

Compilation of data by.....

Drawing Office detailing by.....

Preparation of documents by.....

Particulars of preliminary work already done.....

Signed.....

IMPERIAL CHEMICALS INDUSTRIES LIMITED

FORM (STANDARDS) 2

SUBJECT NO......

This form is to be issued by Committee Secretaries to obtain Divisional opinion on proposed Standards.

From: Imperial Chemical Industries Ltd.,
Standards Section,
Engineering Services Department,
24/30, Gillingham Street,
LONDON, S.W.1.

To:

SUBJECT..... Date.....

.....

The attached proposal, Subject No.....dated.....for the **Initiation / Revision** of an I.C.I. **Standard / Specification / Information Sheet** has been received from .....

Please fill in the attached slip and return on or before..... If no reply is received on or before this date we shall proceed on the assumption that you are not, so far as you are at present aware, directly interested.

.....

From:

To: Imperial Chemical Industries Ltd.,
Standards Section,
Engineering Services Department,
24/30, Gillingham Street,
LONDON, S.W.1.

Date.....

I.C.I. STANDARDS

SUBJECT: ..... *SUBJECT NO.*.....

Please mark X as applicable.

☐ **(a) We agree with the general terms of the proposal.**

☐ **(b) We do not agree that this is a suitable subject for standardisation for the following reason(s) :—**

.....
.....
.....

☐ **(c) We agree with the suitability of this subject for standardisation but will require modification to the proposal.**

- ☐ **Details of our proposed modifications are enclosed herewith on a supplementary Form (Standards) 1.**
- ☐ **Will be forwarded later.**

☐ **(d) We do not agree that this should be explored solely as a Divisional Standard and recommend that it be considered as an I.C.I. Standard.**

☐ **(e) We have special knowledge and experience of this matter and are willing to collaborate.**

☐ **(f) We wish to comment on preliminary drafts as well as on final drafts.**

☐ **(g) We wish to comment on the final draft only when submitted to the Committee for approval.**

☐ **(h) We are not directly interested in the proposed Standard.**

Signed.....

IMPERIAL CHEMICAL INDUSTRIES LIMITED
FORM (STANDARDS) 3

From: Imperial Chemical Industries Ltd.,
Standards Section,
Engineering Services Department,
21/30, Gillingham Street,
LONDON, S.W.1.

To:

Ref: ENS/S/

Date.....
Subject No. .....*Dated*.....

SUBJECT:.....

Form (Standards) 1. Subject No. .....has been circulated and the comments that have been received on Form (Standards) 2, are tabled overleaf.

As a result of the analysis of Divisional comments it is proposed:—

(a) That the work be undertaken as follows:—
Compilation of data by.....
Collaboration by .....
D.O. Detailing by.....
Preparation of Specification by.....
Preparation of Information Sheet by.....

or

(b) That the subject be referred to the.....Committee together with the above analysis.

If no objection is made within **7 days** it will be assumed that the work will be undertaken as indicated above.

This subject will be entered in the "Kardex" at Engineering Services Department and will appear in the appendix to the Secretary's Report for the next Engineering Standards Sub-Committee Meeting.

.....

NATURE OF COMMENT		A	B	D	GC	LC	M	N	PV	P	S	WW	ENS
In general agreement with proposal													
Not in agreement that subject is suitable for standardisation													
In agreement subject to modification* to the proposal (**See below**)													
Wish to consider as an I.C.I. Standard and not as a Divisional Standard													
Have a special knowledge and are willing to collaborate													
Wish to comment on preliminary drafts as well as final drafts of:—	**Standards Sheets**												
	Specifications												
	Information Sheets												
Wish to comment on final drafts only													
Not directly interested													

* *Modifications proposed*

See Supplementary Form Standards attached												
OR												
Will be forwarded later												

HUMAN FACTORS IN TECHNOLOGICAL CHANGE

by Professor C. A. MACE, M.A., D.Litt., F.B.Ps.S.

Professor Mace was born in Norwich and educated at King Edward VI's Middle School, City of Norwich School, and Queen's College, Cambridge.

He has been Lecturer at University College, Nottingham and at the University of St. Andrews, and Reader at Bedford College, London. Since 1944 he has been head of the Department of Psychology at Birkbeck College, University of London.

Professor Mace has divided his interest between philosophy and psychology, and is well-known as an author and speaker on these subjects. He is a Past President of the Aristotelian Society, the Psychology Section of the B.A.A.S., and of the British Psychological Society.

He was a member of the A.A.C.P. Productivity Team on "Education for Management".

Professor C. A. Mace

THEORETICAL science and practical engineering resources have now advanced to a point at which it is no longer fantastic to conceive the possibility of an electronic factory—one in which the human operator is replaced at almost every point by an automatic contrivance of a mechanical or electronic kind. The next step presumably would be to distribute the goods produced through automatic machines. This producer's pipe dream has at least the merit of drawing attention to the fact that, *as we progressively displace the human agent, we reduce both the major sources of resistance to desired change and the major sources of inspiration of desired change.*

In the electronic factory there would indeed be change—the wearing out of parts and eventual breakdown: but *desired* change and the resistance to desired change spring from something inherent in life itself: they derive in part from the homeostatic tendency characteristic of all living things. The organism is a homeostatic device—a system of parts so contrived and so functioning as to maintain certain steady states and to resist all departures from an established norm. This is true not only of living things composed of organic tissues, but also of those living things which we call societies and social organisations, Government departments, public and private bodies of every kind, including even those that exist in order to promote reforms. All are resistant to departures from established norms. Social homeostasis is at the very heart of every problem of technological change. When the forces are such as to maintain a given condition of equilibrium, the problem is one of lowering the resistance to desired change whilst leaving the resistance to undesired change unimpaired. It is a matter of designing a sociological equivalent to the ratchet, an instrument to conserve past gains but allowing further progress in the desired direction.

Advantages of Standardisation

That resistance to change arises in part from the need to conserve and consolidate past achievements is illustrated by the function of standardisation of tools, components and procedures. The uncontrolled spirit of invention and experiment makes for an

uneconomic degree of variation in procedures and products. Hence the advantages of standardisation. Hence, too, the difficulty in further advances. The dangers of premature standardisation are greater when standardisation is brought about not by conscious intention and deliberate organisation, but by tradition and custom. Many things have been standardised by custom without the blessing of the B.S.I. It is most improbable, either in the light of first principles or in the light of studies at the Building Research Station, that the ideal unit of building construction is the brick of any of the conventional dimensions. But what has been standardised by custom is not the bricks, but the skills of men who use these bricks in building. In the scientific study of the process of industrial production we have come to think of the "man-machine unit", of the process of production as dependent upon the adjustment of the machine to the man who uses it, and sometimes perhaps of the adjustment of the man to the machine. We ought perhaps to think of the man-machine-materials unit. Pending the perfection of the automatic factory, production is effected by human beings performing certain operations with tools or machines upon given materials or components. We cannot standardise any one of these contributors to the end result without due regard to the others. There must clearly be some optimal rate of desired technological change in any given direction; and it is clearly to be desired that the rate of change should be in some measure under human control. As yet, however, little is known with assurance concerning the factors that determine the actual rate of technological change.

Three groups of factors can be distinguished straight away. First, there are the factors which determine the rate of production of inventive minds. Second, there are the factors which determine the rate of consumer assimilation. And third, there are the factors which determine the rate at which new ideas can be translated into acceptable goods and services.

Increasing Rate of Discovery

There can be no doubt that the rate of discovery has increased enormously, and is still increasing. This is obvious if we consider the pace of invention throughout the ages distinguished by the prehistorian, or the pace of invention in successive centuries of recorded time. Eras passed between the earlier improvements of the plough or primitive weapons of war, but the pace has so quickened that in many fields of production technological change has been geared, through the seasonal interests of man, to the circuit of the earth round the sun. Each annual model of every make of car is expected to embody improvements. Indeed, the question might fairly be raised whether the actual rate of change is not now in excess of the optimum.

Were we concerned to make the pace still hotter there would be several things to do. One would be to upgrade and develop our primitive system of technical and technological education—defensible enough on a number of other grounds. Scientific method is in itself a technique of discovery as well as a technique of proof, and there are vast areas of research in which invention is reduced almost to routines which are or could be taught in the technical schools. But originality of mind is something more than skill in the use of scientific method. It springs from certain attitudes of mind which at present are fostered only in certain special places. If we review the greater educational institutions of the world—from the ancient universities to the modern institutes of technology—the impression received is that those most productive of creative minds are precisely those in which trained and disciplined intellects are applied to the coolest consideration of the craziest of ideas. If we wished to increase the pace of inventive technological thought, the techniques employed in these institutions could readily be applied in other divisions of our educational system.

The place to begin perhaps is the secondary technical school. There is indeed a powerful case to be argued for making a liberalised system of technical education the main trunk of our education tree. It would need to be "liberalised" by introducing into the curriculum an appropriate selection of arts subjects, for the arts subjects contribute to inventiveness and originality as much as is contributed by science. The technologies, in fact, stand at the point of intersection between the sciences and the arts and between both of these and the practice of the inventive skills. The potter, the weaver, the architect and the designer of machines is, each one of them, if he knows his job, something of an artist, something of a scientist and one who practises a skill. A liberalised secondary technical education could lay the foundations for a balanced appreciation of the scientific, the aesthetic and the practical aspects of life. It is not, of course, to be suggested that we need to create a world composed entirely of inventors, but it is to be suggested that one who lives in the world of today or tomorrow needs to feel at home and at ease in a world of continued technological change. So far as discovery and invention is concerned the pace, it might well be said, is surely hot enough. The problem is to break down the resistance of consumers and producers. The consumer's resistance to change, and his demand for change, are combined in curious ways. We hear more about resistance to change than of the demand for something new, even if it is not better. The latter creates as many problems as the former. In the annual demand for new models of cars, radios, etc., technological change has been caught up in the wheels of fashion. The customer is not always right. He would be always right if he could always say what he really needs. When he says only what he thinks he needs he is not more likely to be right than wrong.

Importance of Advisory Services

Hence the importance of advisory services. One of the most significant features of the times in which we live is the expansion of these services. The farmer

is advised by the Ministry of Agriculture, the builder by the Ministry of Works, and so it is for almost every industry or profession. In his personal affairs a citizen in the modern world has at his disposal medical, educational and innumerable other specialised bureaux dispensing the latest and best advice on any subject of concern to himself or his wife. Nor are such advisory services restricted to official bodies. Large-scale industry has developed similar services which are conducted in a responsible and professional way. Had he the time and the inclination, the citizen could devote the whole of his leisure time to the inexpensive hobby of collecting good advice. But these advisory bodies would seem themselves to stand in need of advice based on a growing body of scientific knowledge of the theory of human communication. In large part, the problems of getting ideas into production are of overcoming consumer resistance and are problems of "communication", meaning by "communication" not merely the transmission of information, but also the induction of a willingness to act in certain ways.

The lines of transmission are of various kinds. There is, for example, the line from the inventor through the research laboratories and test stations to the field of operation. In the process of production there is the line from higher management through the supervisory grades to the operators at the bench who actually do the job. In general, these are not so much lines as expanding circles. Ideas may be conceived in individual minds, but their implementation is a matter of activity on the part of larger and larger groups. In this process of transmission, resistances often increase in a way suggestive of the law of the inverse square; and the measures required to overcome resistances are almost always measures directed not to the individual, but to his group. Most typically, the introduction of a new machine, a new piece of equipment, or a new procedure follows a now fairly well-established routine. Tests are first performed in the research laboratory. The new machine is then transferred to the field station in which it is still tested scientifically, but under as near as may be realistic conditions. Surviving all these tests, it is then tried out under the normal industrial conditions in the hands of ordinary operatives working in the ordinary way and *with normal motivations*. This third phase is apt to be the most critical, but it is one that receives the least attention. There is, in fact, a striking contrast between the precision of scientific testing in the laboratory or field station and the casual procedure in the transference of a new device from the tester to the normal user for whom it is intended. From the nature of the case, user—or consumer—reactions cannot be tested in the laboratory or a field station. Motivations and attitudes are essentially different. There is all the difference in the world between the man in the field station who is excavating a trench in order to test an excavator, and a man on a building site who is using an excavator in order to excavate a trench. Technological inventions need to be tested not only for their physical capacities but also for "acceptability", and the latter tests require to be as searching and as rigorous as the former and every bit as much subject to scientific control. The critical point, the point of maximum resistance, is precisely the point at which some particular individual is required to change some well-established habit, or acquire a new skill.

A Basic Misunderstanding

It is a basic misunderstanding to suppose that all resistance to change arises from sheer irrationality and prejudice. Men are not in general implacably opposed to the acceptance of something to their own advantage, but it is only common prudence to look a plausible gift horse in the mouth. Sheer prejudice is on the whole a less serious obstacle to progress than prejudice reinforced, as it so often is, by a measure of reason and good sense. It is not unnatural and not unreasonable for a man to be anxious at the prospect of loss of employment. When a man has invested not only his money but also his self-respect in the acquisition of rare skills, it is not a joke to find these skills supplanted by a gadget. If there is one lesson which more than any other stands out from the better studies in this field, it is a lesson concerning man's fear of insecurity and his continual need for reassurance. The engineer, thinking only of the time it takes to design, construct and instal a new and better machine, is naturally impatient at the delays imposed by the need endlessly to explain and convince and reassure everyone concerned, not least those in whose interest and for whose benefit the machine has been conceived. Even a labour-saving device makes work harder and calls for further effort *for a time*—during a longer or shorter period of transition from the old to the new. The humane engineer learns to think in terms of the characteristic tempo of biological change—the tempo of growth and adaptation—as well as in terms of the characteristically faster tempo of physical and chemical reactions. A conclusion that can be proved in twenty seconds may take months to get used to. We must often console ourselves with the thought that a new idea cannot continue to be new for ever. Even the temperamental and ingrained conservative, if he thinks about a new idea sufficiently, will end by saying that there's nothing very new in that. Good techniques of presentation will expedite this process.

New Ways of Sucking Eggs

There are cases in which technological changes come about not by changes in persons, but in personnel. New ways of sucking eggs are introduced through the passage of the generations, and this may apply to the techniques of egg production as well. Youth is proverbially susceptible to the arts of the propagandist for any new ideas, and this susceptibility can be turned to good account in technological education. This is yet another reason for the upgrading of the technical schools and colleges, for their closer integration with the organisations for technological research. These schools are in one of the key positions in the lines of communication from

the research laboratories and the field stations. They provide potentially the greatest single medium for feeding into the industrial system not only new ideas, but also a body of technicians and technologists mentally adapted to a world of technological change. Even before the age of nuclear fission, it was being suggested that one of the traits of character most needed for life in the modern world is that of being "adapted to insecurity".

There would seem to be an almost equal need for being "adapted to change". Extreme attitudes in either direction are equally inappropriate, and equally unconducive to ordered progress. There is scope through our educational system and our publicity services to inject into society a pervasive sense of optimum rates of change, and to diffuse among consumers of goods appropriate habits of obsolescence and replacement. Things are made to last a certain time. A razor blade may be intended to serve the purpose only of a single shave; a pyramid is built to last ten thousand years. How long a thing should last is an item to be included in its specification. How long it is intended to last is something which the buyer of a blade or a pyramid has the right to know. He should at least be encouraged to ask. Some goods are sold with a guarantee that they will endure for x years. A buyer might as reasonably ask for a guarantee that they will wear out not so long after that. In any case, he stands in need of advice. We hear of motorists who trade in their cars when the ashtrays are full. We all know motorists who contrive "to run the old bus" long after the cost of maintenance has exceeded what is economic.

It is sometimes suggested that British industry has over-emphasised the importance of durability and quality, and that it would do much better if it designed clothing, cars and buildings so that they wore out. On this there may be more than one opinion. But there can hardly be two opinions on the suggestion that, whatever we do, we should know what we are doing and do what we do with conscious intention. It is a matter of having a policy, so that every man can arrange his purchases with an intelligent regard to obsolescence and replacement.

The prospects of rational control of the rate of technological change have been significantly enhanced during the present century by the improvement of techniques of publicity, advisory and educational services, and by the development of higher ethical and professional codes in the use of these techniques. "High pressure salesmanship" and the exaggeration, in fact downright untruthfulness, of older systems of publicity were themselves major factors in the creation of "sales resistance" and obstacles to desirable change. Publicity today tends to be factual, informative, genuinely advisory and educational.

Advisory services themselves stand in need of advice scientifically based. Although the relevant knowledge is still very sketchy, much more is established than has yet been applied. It is clear from first principles that an advisory service must be based upon knowledge of actual needs, and of the attitudes, tastes and interests of those to be served. Methods have been developed for these needs and attitudes to be assessed with some degree of reliability and precision. It is clear also from first principles that the effectiveness of any communication will depend upon the extent to which the message is delivered *to* the right person, *by* the right person, *in* the right form and *at* the right time. It will also depend upon the extent to which the delivery of the message is followed up, its impact assessed and further communications modified in accordance with the "feed back" received. In this way, the results of "mass diffusion" methods of publicity are supplemented by the direction of specific beams of intelligence upon persons and groups in key situations, timed to arrive at the opportune moment, and the effects produced so checked up that future communications can be suitably adapted to the changing situation. Such techniques of communication admit of development in precision and in a scientific way, and through their systematic application the rate of technological change comes increasingly under control.

The Scientific Approach to the Human Factor

Here again the fact emerges that advance depends upon the application of scientific method to the human factors in the situation. In a world of electronic factories, directed by an electronic management, assisted by electronic servicing engineers, disposing of its products by electronic salesmen to electronic consumers, there might well be no resistance to technological change. Indeed, there might be no technological change to resist. But things have not yet come to that pass. Human management will employ human operators to produce goods and services for human consumers for some time to come. Control of the rate of technological change depends on control of the human factor. This is what emerges at every step in this analysis of the process. The rate of technological change depends upon the rate at which new ideas occur, it depends on the rate new ideas can be transmitted through the relevant lines of communication in production and it depends on the rate of consumer assimilation. It depends, in short, upon the rate at which one man can produce a new idea and the rate at which other men come to be emotionally adapted to its presence. It was the beginning of a major epoch in human history when man first considered thunder and lightning not with superstitious awe, but as natural phenomena to be understood and then perhaps controlled. It was the beginning of a second major epoch when man began to consider himself as a natural phenomenon, when he began to consider the process of creative thinking not as an impenetrable mystery, but as something to be understood and so perhaps controlled, and when he began to respond to the emotional reactions of his fellow men not with gestures of exasperation or despair, but by observation and experiment designed with a view to understanding and eventual control.

If predictions are not entirely out of order, the guess might be hazarded that the next great phase of technological advance will be one in which human factors in the technological situation are accorded the same scientific regard as are given to raw materials and machines; and when technologists begin to think in terms of the man-machine-materials unit.

How and when and where can we set about it? Research and development in the human sciences do not follow quite the same sequence as that of research and development in physics, chemistry and the major branches of engineering. Human reactions can be tested in the laboratory and in the field station, but all the most crucial tests are in the field itself. The responsibility for research and development rests squarely on industry. The research laboratory and the field station must be in the factory and the departmental store. The practical problem is that of siting the research function and defining its place in the organisational chart. Is the function to be linked in the main with central management, with the personnel department or the work study unit? The one place in which it should not be situated is in some odd and inconspicuous hole or corner.

Conclusion

To summarise: the subject of this discussion has been the control of technological change—control not essentially with a view to its acceleration, since in some directions the pace, perhaps, needs to be slackened.

The major instruments of control are those of formal education, those of the advisory services and the new techniques of "communication", and not least the function of research. There would appear to be three major lines of action, the first directed to increasing the output of inventive minds, the second to the promotion of favourable consumer reactions and the third to facilitating the passage of new ideas into actual goods and services.

The first and second of these lines of attack call in the main for operations on a national scale—the promotion of overdue reforms in technical and technological education, and the further development of advisory services. The third is well within the competence of even the small unit of production. It is in fact a problem of production engineering. It is *par excellence* the *human* problem in production engineering.

NEW BUILDING FUND APPEAL

Since the publication of the last list, donations have been received from the following subscribers. (The list was compiled for press on 24th June, 1954.)

C. Arnold, A.M.I.Prod.E.
Augusts Ltd.

J. Bailey, M.I.Prod.E.
J. A. Bailey, M.I.Prod.E.
A. L. Beech, M.I.Prod.E.
M. I. Berkman, Grad.I.Prod.E.
David Brown & Sons.

T. Devine, A.M.I.Prod.E.
A. A. S. Dickson, A.M.I.Prod.E.

C. A. Grayson, M.I.Prod.E.

C. A. Hitchcock, A.M.I.Prod.E.
W. Hodgkisson, M.I.Prod.E.
Hopkinsons Ltd.

H. C. Knott, M.I.Prod.E.

C. Matthews, A.M.I.Prod.E.

W. G. Rooke, A.M.I.Prod.E.
L. Rutter, A.M.I.Prod.E.

J. K. H. Smith, A.M.I.Prod.E.

R. J. Upcott, A.M.I.Prod.E.

L. White, A.M.I.Prod.E.

B. G. York, A.M.I.Prod.E.

WORK STUDY SOCIETY

The Work Study Society, formerly the Motion Study Society of Great Britain, has prepared a fresh prospectus of which copies may be obtained from the Secretary of the Society at Beech House, Heald Green, Cheadle, Cheshire.

The President is Miss Anne G. Shaw, C.B.E., M.A., M.I.Prod.E. and the Vice-President is Mr. G. P. Wade, B.Sc., M.I.Prod.E., A.M.I.E.E. A member of the Society's Council is Mr. A. B. Armstrong, B.Sc., M.I.Prod.E. of the Anne Shaw Organisation Limited.

JOURNAL BINDERS

Members are advised that binding cases for the Journal are available, and may be ordered from Head Office. The cases, which are strongly made and covered in dark red leather cloth, with "The Institution of Production Engineers Journal" in gilt on the spine, will each hold 12 copies of the Journal. The price per case is 10/-, post free.

THE PRINCIPAL OFFICERS, 1954/55

The President

Members will learn with pleasure that Sir Walter Puckey has been elected to a second year of office as President. During the past year, under his Presidency, the Institution has pursued with vigour its progressive policy, and much of the motivating power has been supplied by the President, whose enthusiasm and zeal in Institution matters is known throughout the membership.

Sir Walter has made many visits to Sections during his year of office, and hopes to make many more during the new Session.

Photo by L. E. Broome

Sir Walter Puckey

The Chairman of Council

The newly-elected Chairman of Council of the Institution for the coming year is Mr. G. Ronald Pryor, who is one of the most active members of the Institution. He has served on the Council continuously since 1945, and has been Vice-Chairman for the past two years. In this capacity he recently completed the major task of drawing up new Articles of Association, which were adopted at the Annual General Meeting in January, 1954. He has also been a member of the Finance and General Purposes Committee since 1947.

Mr. G. R. Pryor

Mr. Pryor was born in 1901 and educated at Wellington College, Salop. In 1919 he was apprenticed to the family firm of Edward Pryor & Son, Limited, of Sheffield, which was founded in 1843, and of which company he is now the Chairman and Managing Director. He is also Chairman of The Rollem Patent Products, Limited, Ecclesfield, and of Punch Forgers, Limited, Sheffield.

Sheffield has always claimed a major share of Mr. Pryor's time and he is actively concerned with business and industrial interests there, where he is very well-known and widely respected. He is a past President of the Sheffield Section of the Institution. He is also a past Chairman of the Sheffield Section of the Institute of Industrial Administration, of which body he is a Fellow. He has served on the Council of the Sheffield Chamber of Commerce since 1951 and was subsequently appointed Vice-Chairman of the Education Committee of the Chamber. In 1953, he was appointed a member of the Commerce Committee of the Yorkshire Council for Further Education.

Mr. Pryor takes a keen interest in production research and has served on the Council of the Pro-

duction Engineering Research Association of Great Britain since 1950, and on the Executive Committee of this body since 1951.

He is a man of very wide interests and among his hobbies are beagling, sailing, ornithology and photography. He also enjoys travelling and has visited most European countries, Canada, and the United States.

Mr. Pryor's wise counsel and experienced guidance have been demonstrated on many occasions in the past, and will be even more appreciated by the Institution during his term of office as Chairman of Council.

The Vice-Chairman of Council

Mr. H. G. Gregory, Manager (Northern Factories) of the Fairey Aviation Company, Limited, Stockport, has been elected Vice-Chairman of Council, 1954/55. Mr. Gregory is a past President of the Manchester Section of the Institution, and a past member of the Membership, Standards, and Hazleton Memorial Library Committees.

COUNCIL ELECTIONS 1954/55

As a result of the Ballot the following Members have been elected to serve for the year 1954/55 :

Members :

A. J. Aiers	A. G. Clark	F. J. Everest	Prof. T. U. Matthew
H. W. Bowen, O.B.E.	Wm. Core	R. S. Hind	A. L. Stuchbery
R. S. Brown	B. H. Dyson	B. G. L. Jackman	C. Timms
R. M. Buckle	E. P. Edwards	R. Kirchner	R. H. S. Turner

Associate Members :

R. S. Clark	B. E. Stokes

The next Council Meeting will be held at 10, Chesterfield Street, London, W.1, on Thursday, 22nd July, 1954, at 11 a.m.

Honours

The Institution records with pleasure the following awards made to members in Her Majesty the Queen's Birthday Honours List :

O.B.E. Mr. E. W. Field, Member, Managing Director of H. W. Ward and Co. Ltd., Birmingham.
Mr. F. Grimshaw, Member, General Works Engineer of Leyland Motors, Ltd., Preston. Mr. Grimshaw is a corresponding member of the Institution's Papers Committee.

M.B.E. Mr. F. T. West, Member, Principal of Southampton Technical College. Mr. West is Chairman-elect of the Southern Region.

Halifax Graduate Section Weekend School

It is announced by the Halifax Section that their third Weekend School will be held in the Cranleigh Hotel, near Ilkley, on 18th and 19th September, 1954.

This will be the first time that the school will be organised on a regional basis incorporating the Sheffield, Yorkshire and Halifax Graduate Sections.

New Section on Tees-side

The newly-formed Tees-side Section held its first meeting as a Section on 24th May, 1954, when the Chairman and Committee were elected, as follows :

Chairman : Mr. R. H. Archer.

Hon. Secretary : Mr. T. A. Horsley.

Committee : Messrs. J. H. Cooper; D. Crawcour (additional representative on Regional Committee); T. B. Hall (Vice-Chairman); R. Horn; R. G. Monkhouse; A. Smith; R. H. M. Trew; T. D. Walshaw (additional representative on Regional Committee); and L. G. Wise.

Following the elections, considerable discussion took place concerning the Section's future activities. It was proposed that the inaugural meeting should be held in September, 1954, and that the President of the Institution, Sir Walter Puckey, be invited to give the main address. The Principal Officers would also be invited to attend this meeting, which would be treated as a Regional function.

At present there are approximately fifty members in the Tees-side area, and under the direction of the enthusiastic Committee, there is no doubt that the Section will make marked progress.

Institution Staff

Mr. C. Barker, the Institution's printer, who is well-known to many members, has recently completed 20 years' service on the staff. He came to the Institution in May, 1934, at the age of 14, and commenced his service under the late General Secretary, Mr. Richard Hazleton. At that time the permanent staff numbered five, and the Institution membership was approximately 1,500.

During the Second World War Mr. Barker served in the Royal Navy from 1940/45, and returned to the Institution immediately he was demobilised.

Another member of the staff, Mrs. M. Ingram, who was married recently, last month left the Institution after nearly ten years' service. She was engaged in 1945 as telephonist/receptionist, and for the last five years was Head of the Institution's Registry and Filing Department.

Mr. C. Barker

Mrs. M. Ingram

The President, Sir Walter Puckey, and Mr. Harold Burke, Chairman of Council, have conveyed their personal congratulations to Mrs. Ingram and Mr. Barker on their long service.

news of members

Mr. Austin Albu, M.P., Member, has been appointed a member of the governing body of the Imperial College.

Sir George E. Bailey, C.B.E., M.C., Member, a Past President of the Institution, has been elected President of the British Electrical and Allied Manufacturers' Association. Sir George Bailey, who has been Chairman of Associated Electrical Industries, Limited, since 1951, is Chairman of Metropolitan-Vickers Electrical Co. and A.E.I. subsidiary, and also associated with a number of other Companies controlled or associated with A.E.I. In the course of his distinguished career he has occupied a number of important public offices. He is past President of the Manchester District Engineering Employers' Association and the Engineering and Allied Employers' National Federation. During the second World War he was Chairman of the Local Reconstruction Panel (Manchester Area), Emergency Services Organisation, and a member of the industrial panels of the Ministries of Labour and National Service and Production. He also served in 1941 on the Committee on Skilled Men in the Services, presided over by Sir William Beveridge.

Mr. William Bentley, M.B.E., Member, a joint managing director of Bentley Engineering Co. Ltd., Leicester, has been appointed Chairman and Managing Director of Mellor Bromley and Co. Ltd. He retains his position on the board and the chairmanship of Pegson Limited of Coalville and other members of the Bentley group.

Mr. H. W. Bowen, O.B.E., Member, has been appointed Technical Director to H. J. Baldwin and Co. Ltd. and consulting engineer to the Baldwin group of companies. Mr. Bowen, who is a member of Council and a Past President of the London Section, was formerly Managing Director of the Britannic Electric Cable and Construction Co. Ltd., which appointment he took up after being associated with E.M.I. for 13 years. Mr. Bowen is also a Director of Air Trainers Limited, Clark Matthew

Limited, and Chairman of High Pressure Components Limited.

Mr. W. Fenton, Member, has now returned to England after four years service in Sao Paulo Brasil, as Technical Director to Industria Yorkshire do Brasil, S.A.

Mr. H. Ashford, Associate Member, has now resigned his commission in the Royal Air Force to take an appointment as a Senior Professional Officer, in the Central Mechanical Equipment Department of Southern Rhodesia.

Mr. J. H. Ayre, Associate Member, has now taken up an appointment as Lecturer in charge of Engineering at Forest of Dean Mining and Technical College.

Mr. G. C. Bateman, Associate Member, has been appointed Direct Factory representative for Lidkopings Mekaniska Verkstads Aktiebolag, Lidkoping, Sweden, and Ulvsunda Verkstader Aktiebolag, Ulvsunda, Stockholm, in the United Kingdom and other countries. Mr. Bateman, who is a grinding machine specialist, is at present in the U.S.A. on behalf of Messrs. Lidkopings and Ulvsunda and when operating in the United Kingdom will be located at Wickman Limited, Factored Machine Tool Division, Coventry.

Mr. S. R. J. Goddard, Associate Member, has now relinquished his position with Plessey Company, Ilford, as Production Development Engineer, and is now Production Engineer for the Rheostatic Company Limited.

Mr. Arthur Hollen, Associate Member, formerly Northern Technical representative, has been appointed a Director of the Lapointe Machine Tool Co. Ltd.

Mr. W. A. Leeson, Associate Member, has recently left this country to visit the Gleason Works in America.

Mr. G. Pool, Associate Member, has left the United Kingdom to take up an appointment as General Manager of a new subsidiary of C. A. Parsons & Co. Ltd., in South Australia. He will make his home at Wyalla, near Adelaide. Mr. Pool served his apprenticeship with C. A. Parsons & Co. Ltd. and subsequently became Technical Assistant to the Works Manager and latterly erecting shops superintendent. Mr. Pool was a founder member of the North Eastern Graduate Section of the Institution, of which he was Chairman 1948 - 49.

Mr. G. Pool

Mr. S. N. Popkin, Associate Member, has been appointed Assistant Manager (Planning), at the Royal Ordnance Factory, Leeds.

Mr. A. G. Pate, Associate Member, has recently been appointed to the Board of Directors of Woodward & Styles Limited.

Mr. R. H. Unwin, Associate Member, until recently a director of Ambrose Shardlow & Company Limited, of Sheffield, has been appointed Export Manager of The Newall Group Sales Ltd. With the exception of a short period spent with A. V. Roe, Manchester, Mr. Unwin has been on the staff of Ambrose Shardlow & Company since 1923 when he joined the organisation as a jig and tool draughtsman. After holding a number of executive positions in the Company he was appointed Works Director in 1947 and a director in 1948.

Mr. T. B. Worth, Member, Principal Senior Lecturer in Production Engineering and Assistant Head of the Department of Mechanical and Production Engineering of the Birmingham College of Technology, is carrying out a Technical Assistance Project in America, on the nomination of the Ministry of Education.

The purpose of the project, which will occupy about six months, is to observe and gain experience of American methods of training in industrial engineering and management both in Universities and industrial plants.

The project is under the auspices of the Foreign Operations Administration Mission at the American Embassy.

Mr. H. Gurvick, Graduate, has now taken up an appointment as Technical Assistant to the Works Manager of Messrs. G. D. Peters & Company Limited.

Mr. R. D. Guthrie, Graduate, has now taken over the position of Works Manager (Engineering), at Jury Holloware Limited.

Mr. T. Keenan, Graduate, has now taken up a position in Canada with Lucas-Rotax Limited, as Production Planning Engineer.

Mr. L. J. Saunders, Graduate, has been appointed Replacement Bearing Officer with his present firm, The Glacier Metal Co. Ltd. Mr. Saunders is Hon. Secretary of the London Graduate Section, and a member of the Hazleton Memorial Library Committee.

Members are asked to note that the Library will normally be open between 10 a.m. and 5.30 p.m. from Monday to Friday each week. It would be helpful if, in addition to the title, the author's name and the classification number could be quoted when ordering books.

Members are reminded that the Library service is available to all members of the Institution and the Librarian is always willing to assist with enquiries.

REVIEWS

620.1 STRENGTH OF MATERIALS

"Strength of Materials" by G. H. Ryder. *London, Cleaver-Hume Press Ltd.*, 1953. 278 *pages. Diagrams.* £1. 1. 0.

There has long been a need for a clear and concisely written book such as this, as from past experience it has been found that most text books suffer from the disadvantage of being difficult to read. This book is completely new and offers a modern treatment with clarity of expression in this subject and should be of particular value to students, as the manner of presentation is similar to that in our technical schools and colleges. For this reason alone, it may prove particularly helpful in so far as the student may not have to adjust his mind to a different presentation, and will be able readily to follow the manner of reasoning.

The book is based on the syllabus of the University of London and the contents range through the various forms of stress, shearing force and bending moment, torsion, beams, curved bars and rigid frames, springs, cylinders and spheres, rotating discs, vibrations and critical speeds, etc. The only prior knowledge assumed is of applied mechanics and elementary calculus. There are additional chapters on riveted joints, reinforced concrete and continuous beams, and these are carried to a stage which is normally associated with Theory of Structures. Each chapter is complete in itself and starts with assumptions and theory which is built up concisely and logically and, differing from the usual text book, the author does not let the theory comprise the main part of any chapter but carries on to give a wide variety of problems, both numerical and graphical which are of a modern standard. At the end of each chapter there is a list of examples and works of reference for the use of readers wishing to extend their knowledge of a particular branch of the work.

It was a pleasure to see that the section on material testing has been kept to a minimum, sufficient to enlighten the engineer on the value and significance of mechanical properties.

The symbols used suffer some change from those usually accepted and it is up to the student to decide whether or not this has any advantage over the old system.

In short, a good book in every way, and one which should prove an asset to all students preparing for the Higher National Certificate, Professional Institution examinations, as well as those following a degree course. F.W.H.

"Industrial Leadership and Joint Consultation: A Study of Human Relations in three Merseyside firms" by W. H. Scott. *Liverpool, University Press*, 1952. 210 *pages.* 12/6d.

Many books have appeared recently regarding joint consultation, but here for the first time we have a book which examines the result of joint consultation and presents it in a straightforward easy-to-read manner. This book is the result of a study of three separate organisations and the findings show that it is not possible to study joint consultation by itself, but the whole operation of personal relations is interwoven with existing loyalties and suspicions.

The book shows that the type of joint consultative organisations practised in one organisation are not necessarily of use in another factory, unless modified.

This book is well worth reading, especially by those who are concerned with industrial relationship inside factories. R. T.

"Women's Attitudes to Repetitive Work" by D. Cox, assisted by K. M. D. Sharp and D. H. Irvine. *London, National Institute of Industrial Psychology*, 1953. 60 *pages.* 2/6d.

This report is based on a study which was undertaken to find which aspects of the organisation of repetitive work seem to afford the female worker satisfaction or to cause dissatisfaction; 160 women engaged on 35 repetitive operations were selected at random in six factories. They were employed on a variety of jobs such as magneto armature winding, carton stitching, food packing and clerical work. Most of the women were paid time-rate only, but some participated in bonus or profit-sharing schemes.

Following a detailed examination of the operations concerned, a number of job characteristics was listed such as time to learn the job, work-flow, pacing, posture, and variety of product. The selected operatives were then interviewed individually with the object of finding out how far the factors connected with their job made for satisfaction or dissatisfaction. The interviews, which lasted between 30 - 75 minutes each, were controlled to the extent of guiding the workers' attention to the relevant factors, and the remarks made by the operatives were recorded.

As would be expected, contrasting opinions were expressed on many of the features of their work; for example, some liked being paced, others disliked it. A fair degree of consistency, however, was found in the comments on certain aspects of their work, indicating general preference for diversity in the job, good work-flow and methods, team work, variety of product and the opportunity to sit or stand at will at the job.

The need for emotional security was evident from some of the comments made; and the satisfaction in "seeing the results of one's efforts" and the dislike of having one's creative efforts frustrated is illustrated by the many criticisms of poor work-flow methods and so on, made as much by the time-rate workers as by others.

The report describes the job study and interview procedures, and the method of analysing the data obtained; conclusions are drawn concerning the scope for further investigation. The presentation and clarity of expression are good, and an adequate list of references is given. Detailed Appendices are also included

covering the forms used in the job studies and interviews; job descriptions; and a summary of comments made.

The main aspects of repetitive work which it is felt might warrant further investigation are considered under three headings — freedom, security and creativeness.

It is suggested that repetitive work is often organised so that the element of constraint, e.g. in method and pace of working, is greater than it need be, and that greater freedom of action would be beneficial.

The report in itself is of little value to anyone seeking the answer to a particular problem. "The study was intended to clarify the questions which should be asked about repetitive work rather than to provide answers to them." In this it has succeeded and lines along which further investigation should be made are suggested. G.A.H.

"Dimensioning of Engineering Drawings" by W. Abbott. *London, Blackie,* 1953. 186 *pages. Diagrams.* 10/6d.

To describe briefly the contents of this book one cannot do better than to quote the first paragraph of the preface: "This book deals with the fundamental principles which apply to the dimensioning of drawings for engineering components in their finished state, in the manufacture of which interchangeability is a paramount requirement. It is concerned with the distribution of tolerances previously decided upon, NOT with the determination of these tolerances."

Chapters are devoted to all of the facets of the problem, including size and form, surface texture, also the theory of probability and its impact on dimensioning.

During the past few years a great deal of work has been undertaken on the subject of dimensioning. The best-known forerunner to the book under review is "Dimensional Analysis of Engineering Designs, H.M.S.O., 1948", and this, together with B.S.308: 1953, Engineering Drawing Practice, comprise what may be called the official literature on the subject. This book is complementary to these two publications, inasmuch as Dr. Abbott has explained the principles involved and has also given the reader a commonsense basis upon which to build his dimensioning technique. The last chapter is worthy of special attention. It deals with the theory of probability and its impact on dimensioning. The author clearly shows how the cost of production may be reduced by the application of this theory.

This book falls between the categories of reference book and text book and requires careful study to extract all the information that is presented.

Dr. Abbott has specialised in this subject and few people, if any, are better qualified or connected to offer a book of this type, which has such a general appeal that all connected with actual production could profit by a careful study of its pages. This book may well become the standard work on the subject, and if its use results in a reduction of drawing ambiguities then the author will be suitably repaid for his labour. S.R.S.

"Electrical Contractor's Annual 1954" 2nd edition. Compiled under the editorship of I. Rosslyn-Stuart. *London, E. & F. N. Spon, Ltd.* 358 *pages. Illustrations.* Diagrams. 18/-

The majority of the contents of this book are of a somewhat specialised character, and are outside the normal scope of the production engineer. In this category may be placed the chapters on panel design, wiring of farm buildings and television servicing. Those relevant to engineering include two chapters on lighting, and one on the operation of lifts, as well as details on the suppression of radio interference and on earth leakage trips. Finally, a section on new equipment and accessories is divided between items having only a domestic application, and those of interest also to industry. M.J.S.

"Geographical Features of the Automation of Industry" by David G. Osborn. *Chicago, University of Chicago, Dept. of Geography,* 1953. 106 *pages. Illustrations, map.* $3.00.

For those who are interested in philosophical dissertations and for those who are concerned with process engineering, this research Paper will be of considerable interest. But it is doubtful whether the engineer who is pursuing automation from the viewpoint of the machine shop will find much of interest. The author sets out to discover a link between automation and geography. In his own words, "One of the major problems in the field of the geography of manufacturing that needs to be studied is the impact of new techniques upon the occupance pattern of industry . . . There have been many process changes which have altered location patterns in industries and economic activities. Studies by geographers concentrating on the relationships between changes in *process* on the one hand, and the pattern of human occupance on the other, are scarce. This study is probably one of the first geographic studies with this in focus."

The author in this study deals with twelve companies which are interested in or have introduced automation. These are: Univac computer, plant maintenance, lubrication, Riverlake Belt Conveyor, chocolate refining, bottling line, continuous-flow napalm, centralised traffic control, electricity generation, grain sorghum plant, lard rendering, railroad classification yard, printed circuit fabrication. In these he notes the percentage change in employee requirements per unit of output and the percentage by which space requirements were changed in these processes due to automation, and also the percentage change in productivity in the cases studied.

From the foregoing he makes several interesting deductions in regard to the occupation by industry of land, buildings and parking space for employees' cars and so forth.

He shows that in the grain sorghum plant automation made it possible to locate the works at Corpus Christi, Texas, far away from any town and in a position on the sea front where the dangerous fumes and explosive dust are automatically swept out by sea breezes. The plant location also serves an area with cattle food, which is a by-product of the process. This is typical of the comment on automation which will be found in this Paper. Again to quote: "Automation brings human occupance a step closer to an ideal of possible decentralisation. Automatic factories free of metropolitan labor forces, located flexibly in interchangeable energy grids, and served by automatic transportation, could be established in a wilderness or a desert". The automatic transportation referred to is taken from the example of the Riverlake Belt Conveyor which transports coal from East Liverpool on the Ohio River to Lorain on Lake Erie and returns ore from Lorain to East Liverpool, Youngstown and Cleveland.

As to whether the deductions made in the Paper have any real validity one could feel some honest doubts but, as indicated, it makes an excellent philosophic discussion and the Paper is full of references which will be most useful to those who are studying process engineering. It would seem that there are far too many variables to establish any real pattern of "occupance" arising out of the growing process of automation. F.G.W.

"Manual on Cutting of Metals with Single-point Tools." 2nd Edition. *New York, American Society of Mechanical Engineers,* 1952. 546 *pages. Illustrations. Diagrams.* £3. 15. 0.

Many production engineers will know this valuable work in its first edition (1939) as the most comprehensive collection of data available on metal cutting. The new edition is intended to make available in practical form the essential matter of the earlier edition,

together with many new developments introduced in the last thirteen years. In his research work on this subject, Dr. G. Schlesinger distinguished no less than sixteen variables, an indication of the intractable nature of metal cutting as an applied science. Ever since F. W. Taylor signposted the way in his Presidential address: "On the Art of Cutting Metals", before the A.S.M.E. in 1906, research workers have been probing these variables in a steady stream of Papers, the majority of which remain unknown to the shop man. The task of the Committee and Editor responsible for this work has been one of sifting and arranging this research to present the practical worker with the most significant findings in a form which he can comprehend, and to which reference on individual points is rapid and adequate.

The summary contained in the preface to the second edition indicates the scope of the work:

I. Types, uses and preparation of single point tools—American Standard nomenclature, standard types and sizes of tools, tips, inserts, and holders; tool materials, grinding, evaluating tool performance.

II. Mechanical characteristics and structures of work material—influence of metallurgical structure on machineability, chip formation and control, factors in influencing surface finish.

III. Definitions, functions and classification of cutting fluids—influence on cutting speeds, best rates of depth to feed, practical cutting fluid recommendations.

IV. Cutting forces; gross and net power at the cutter—tools, speeds and feeds for machining a variety of metals, including high nickel alloys, stainless steels, copper alloys, cast iron, and plastics.

V. Net unit power for machining a great number of metals using a single size of cut—formulae for computing power required for other cuts, correction factors for various tool angles, computation of motor capacity requirements.

VI. Economics of metal cutting—Costs of cutting, idle and loading time, tool changing and grinding; cost per piece formula, calculation of minimum cost per piece and of tool life for maximum production rate.

VII. Tabular data on cutting speeds and horsepower for various feeds and depths of cut when turning steel and cast iron—nine chapters with 322 tables. (Reproduced from the First Edition, for ready reference).

The painstaking thoroughness of preparation, excellent typography, clear illustrations, graphs and nomograms, and very adequate index reveal the conscientiousness and indefatigable labours of those responsible for its compilation. The bibliography at the end of most chapters gives reference to many original sources, principally American.

Parts II and III, influence of metallurgical structure and cutting fluids, will repay careful study, as other literature on these subjects is, by comparison, scanty. While useful data on machining aluminium alloys appear in other parts of the text, their omission from the variety of metals treated more fully in the latter portion of Part IV is hard to understand. The influence of chip proportions (depth to feed ratio) on cutting efficiency is somewhat buried in a discussion primarily concerned with cutting fluids, (page 167) and no attention is drawn to this point when discussing the economics of cutting in Part VI.

This is a work of major importance which should find its way into every Jig and Tool, Planning and Machine Shop Foreman's Office. A.J.L.

OTHER ADDITIONS

621.99 SCREW MANUFACTURE

Reed Rolled Thread Die Co., Worcester, Mass. **"Engineering Data on Thread and Form Rolling."** *Worcester, the Company*, 1952. 41 *pages. Diagrams.* $1.00

648 LAUNDRY WORK

Hyam, Florian J. **"Increasing Laundry Output: Economy as applied to the Laundry Industry."** *London, Trader Pub. Co., Ltd., for Power Laundry*, 1947. 152 *pages. Illustrated. Diagrams.*

657 ACCOUNTANCY

Institute of Cost and Works Accountants, London. **"Accountancy of Changing Price Levels."** *London, the Institute*, 1952. 24 *pages.* 2/6.

658 INDUSTRIAL ORGANISATION; MANAGEMENT

Brown, Wilfred. **"Some Problems of a Factory: an Analysis of Industrial Institutions."** *London, Institute of Personnel Management*, 1953. 19 *pages.* 3/- (I.P.M. Occasional Papers No. 2).

Dovey, H. O. **"Handbook of Organisation and Methods Techniques."** *2nd ed. Brussels, International Institute of Administrative Sciences*, 1953. 61 *pages.* 4/4.

Lasser, J. K. **"How to Run a Small Business."** *New York, McGraw-Hill*, 1950. 350 *pages.*

Livingstone, Robert Teviot. **"Engineering of Organisation and Management."** *New York, McGraw-Hill*, 1949. 247 *pages.*

Raymond, John. **"Problems of Delegation of Authority."** *Birmingham, Industrial Administration Group (and Institute of Industrial Supervisors)*, 1954. 15 *pages.* 2/-.

621.92 GRINDING; POLISHING

Lewis, Kenneth B. **"The Grinding Wheel: a Textbook of Modern Grinding Practice."** Under the auspices of the Grinding Wheel Institute, *Greendale, Mass.* Greendale, Grinding Wheel Institute, 1951. 409 *pages. Illustrated. Diagrams.* £1. 8. 0.

Shaw, Thomas R. **"Grinding Machines and Their Use."** *London, Pitman*, 1921. 114 *pages. Illustrated. Diagrams.* (Pitman's Technical Primers.)

621.93 METAL SAWING AND CUTTING

Grinding Wheel Institute, *Cleveland, Ohio.* **"Cutting-off Wheels."** *Cleveland, the Institute*, 1953. 19 *pages. Illustrated. Diagrams.*

621.94 AUTOMATIC SCREW MACHINES

Index Automatic Machine Co. Ltd., *Birmingham.* **"Index O.N. High Speed Automatic Screw Machine: Operator's Handbook."** *Birmingham, the Company* [n.d.] 97 *pages. Illustrated. Diagrams.*

Index Automatic Machine Co. Ltd., *Birmingham.* **"Operator's Handbook for Index 24, 36, 52 Single Spindle Automatic Screw Machines."** *Birmingham, the Company* [n.d.] 52 *pages. Illustrated. Diagrams.*

621.96 STAMPING, PUNCHING, ETC.

Tucker, William C. **"Punching, Shearing, Bending: a Handbook of Descriptive and Engineering Information."** *Buffalo, N.Y., Buffalo Forge Co.*, 1951. 80 *pages. Illustrated.* $3.00.

621.97 PRESS WORK

Reynolds Metals Company, *Louisville, Ky.* **"Designing with Aluminium Extrusions."** *Louisville, the Company*, 1952. 137 *pages. Illustrated. Diagrams.*

628.9 ILLUMINATION

Hughes, G. Bernard. **"Modern Industrial Lighting."** *London, Hutchinson's Scientific & Technical Publications*, 1948. 128 *pages. Illustrated. Diagrams.*

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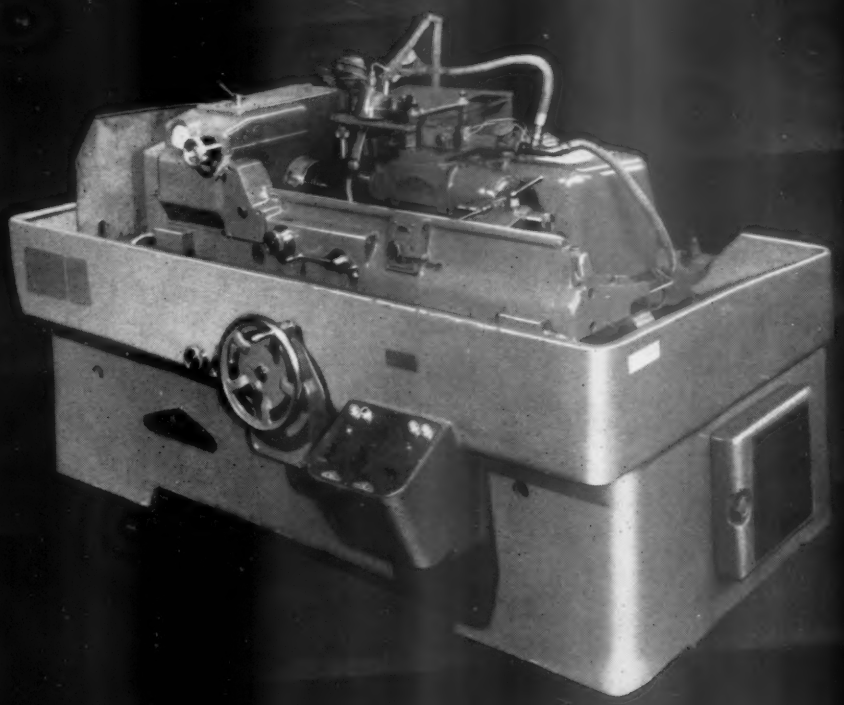

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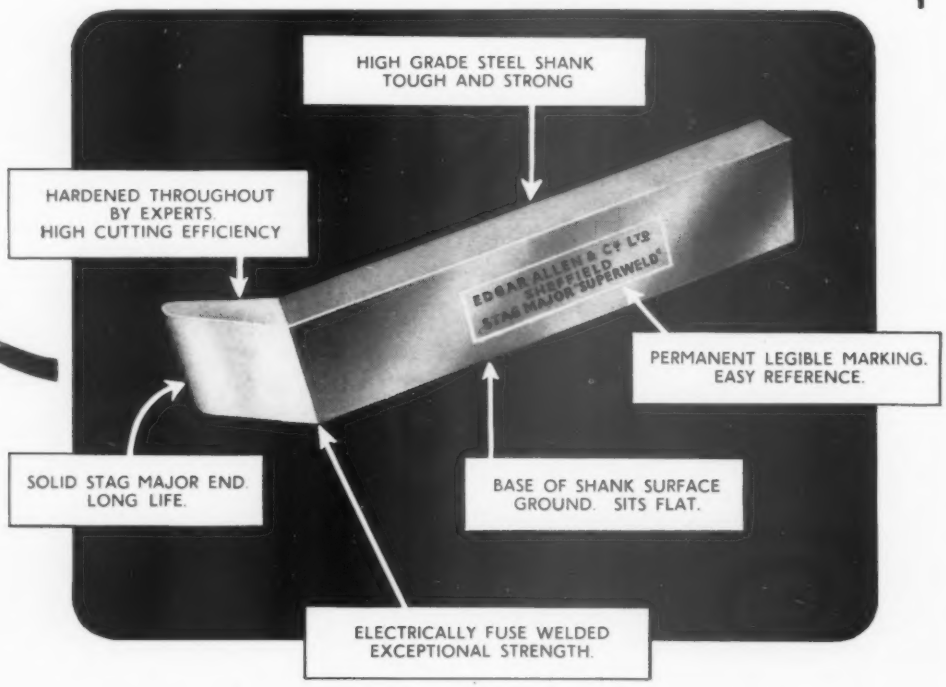
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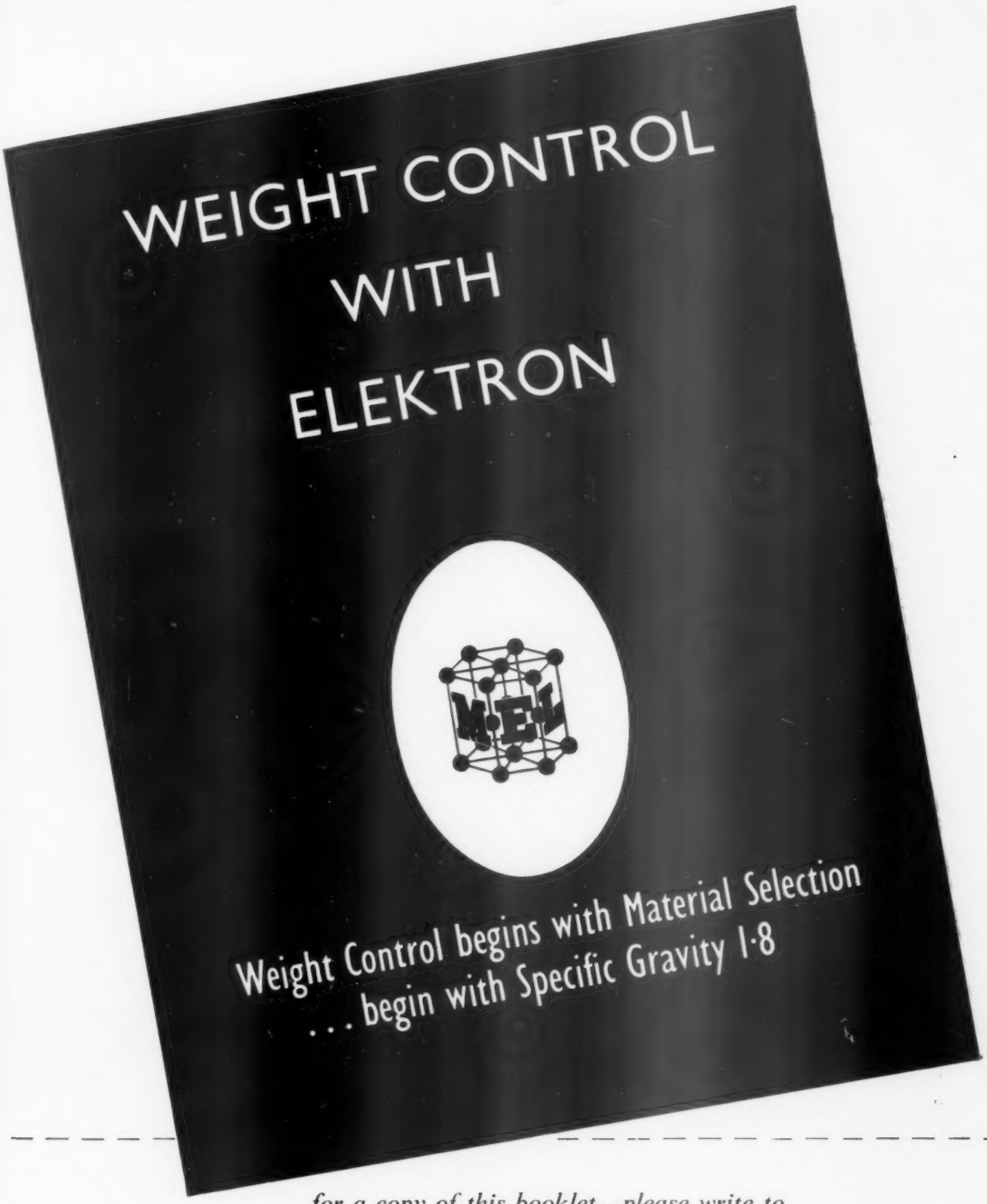

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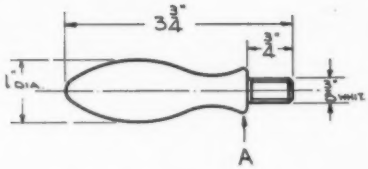

STEM HANDLE

1" dia. Free Cutting Mild Steel Bar, En.1.

High Speed Steel Cutting Tools

Ward

No. 2A CAPSTAN LATHE

Floor to Floor Time: 70 seconds

DESCRIPTION OF OPERATION	Tool Position		Spindle Speed R.P.M.	Surface Speed Ft. per Min.	* Feed Cuts per inch
	Hex.Turret	Cross-slide			
Feed to Stop and close chuck	1	—	—	—	—
Multiple Roller Turn Two dias. A and ⅜" dia.	2	—	2041	535	120
Roller End and Chamfer	3	—	2041	200	Hand
Support and Form	4	Rear	605/95	160/25	Hand
Screw ⅜" Whit.	5	—	605	60	16 T.P.I.
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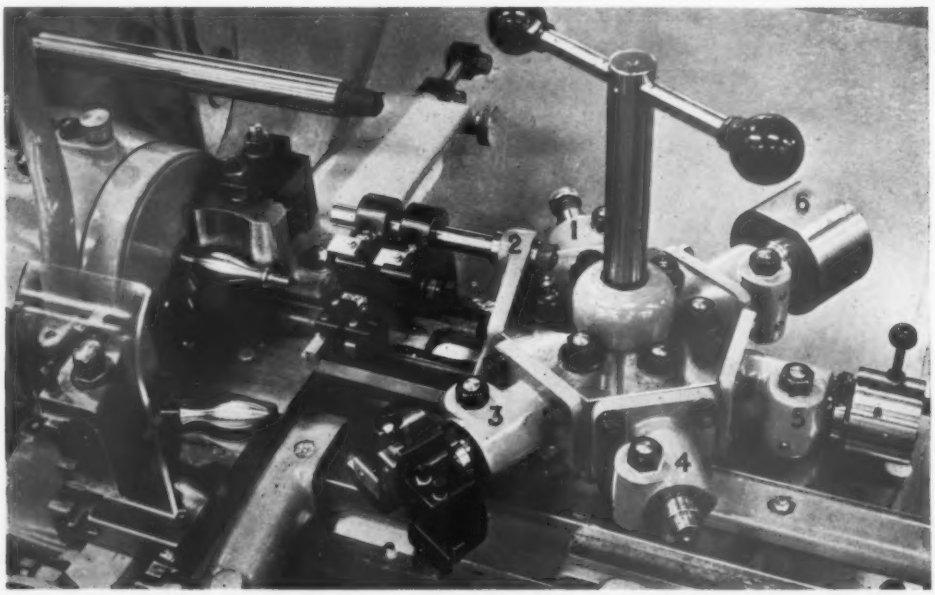

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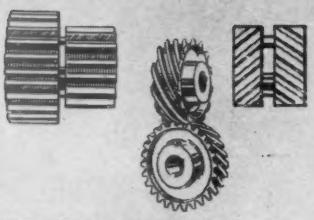

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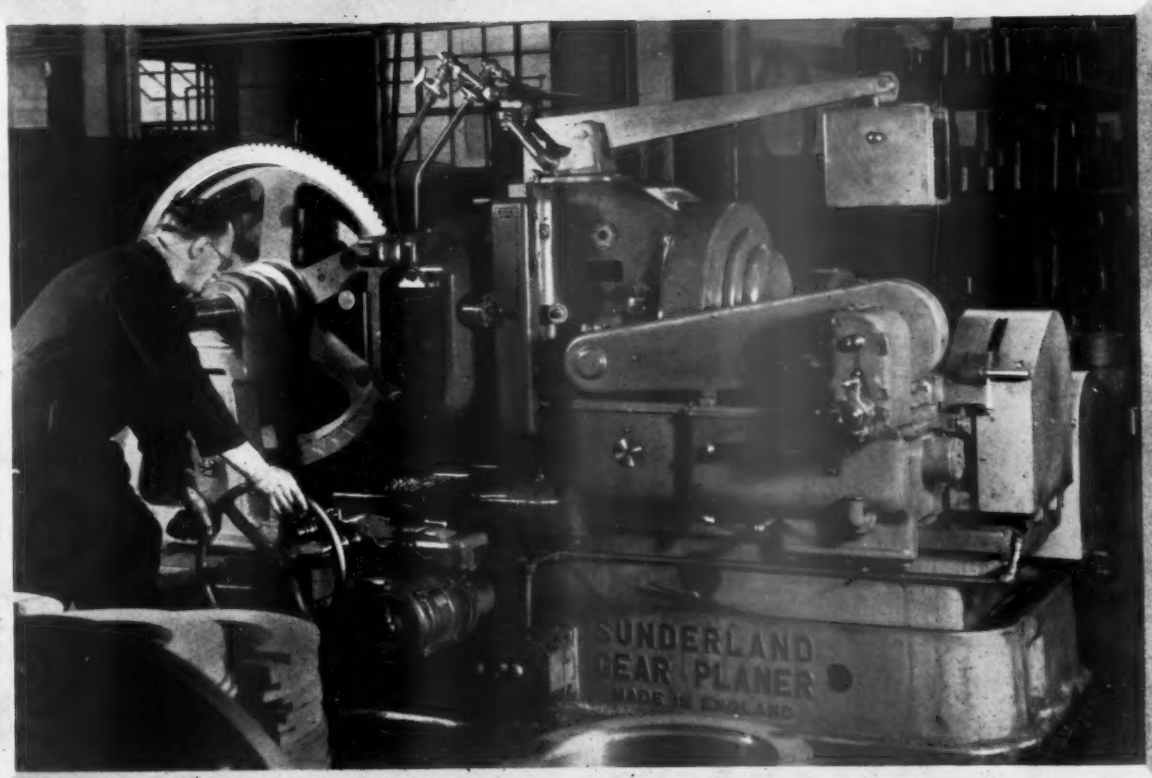

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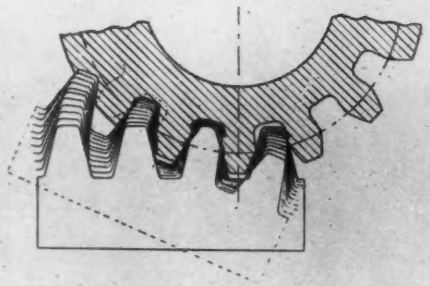

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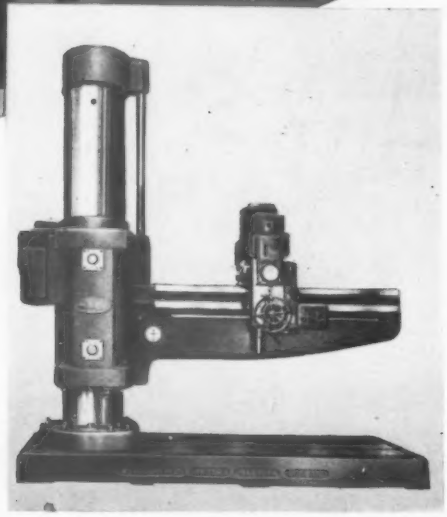

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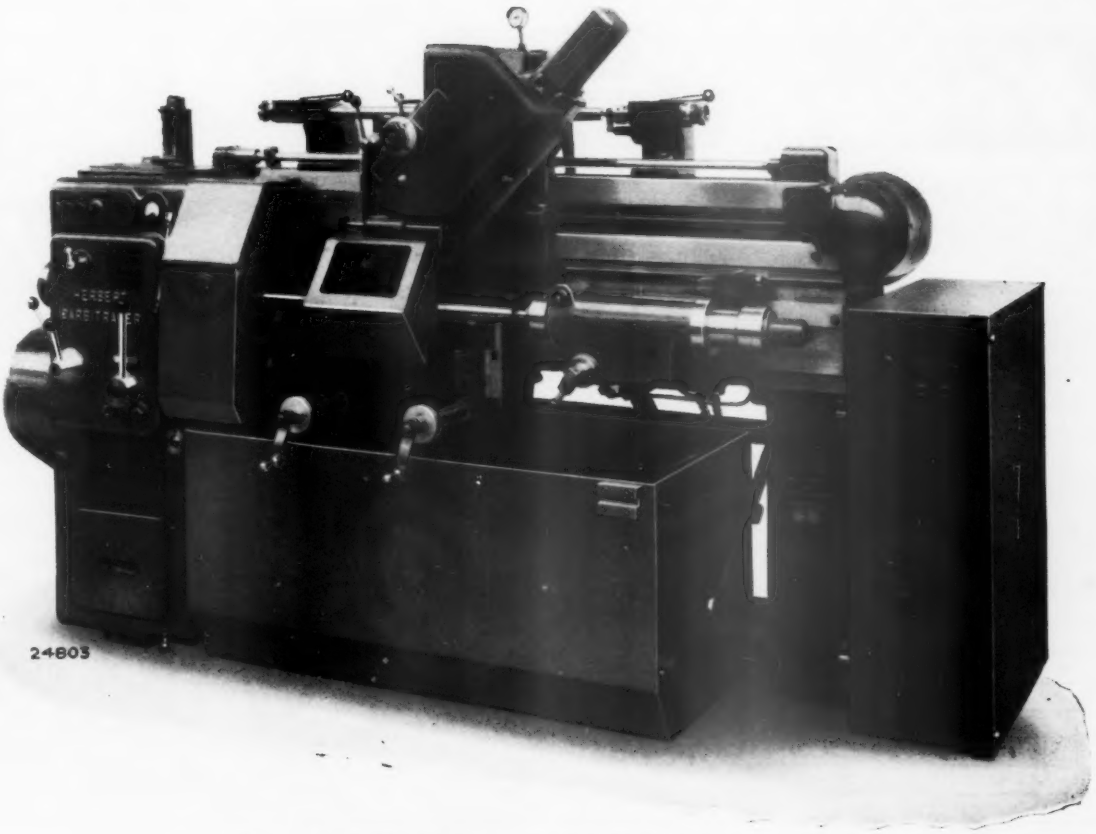

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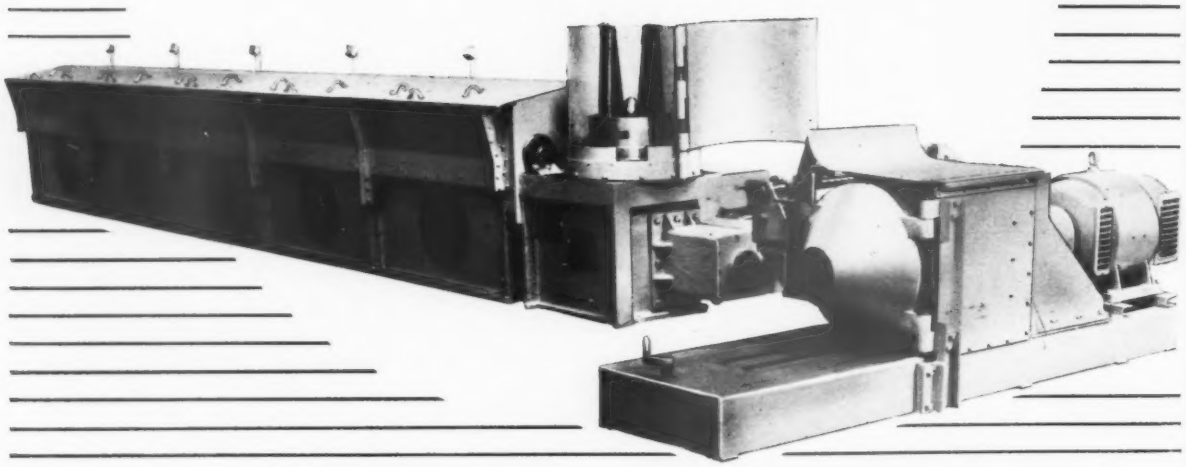

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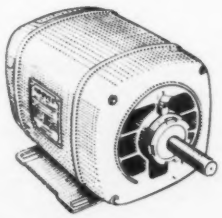

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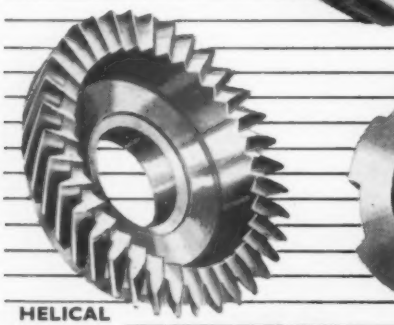
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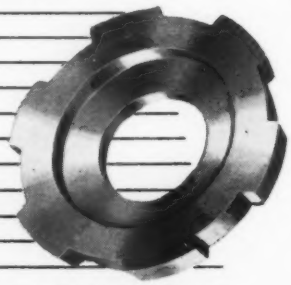
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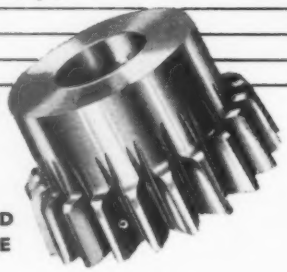
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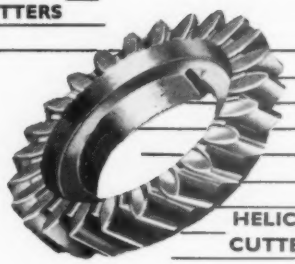
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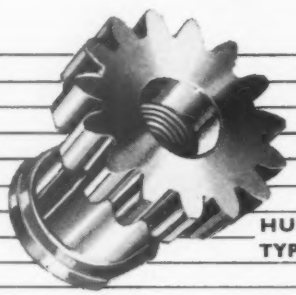
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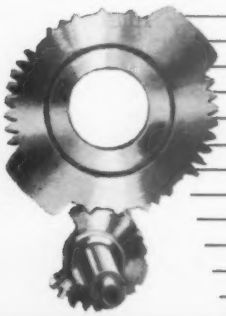
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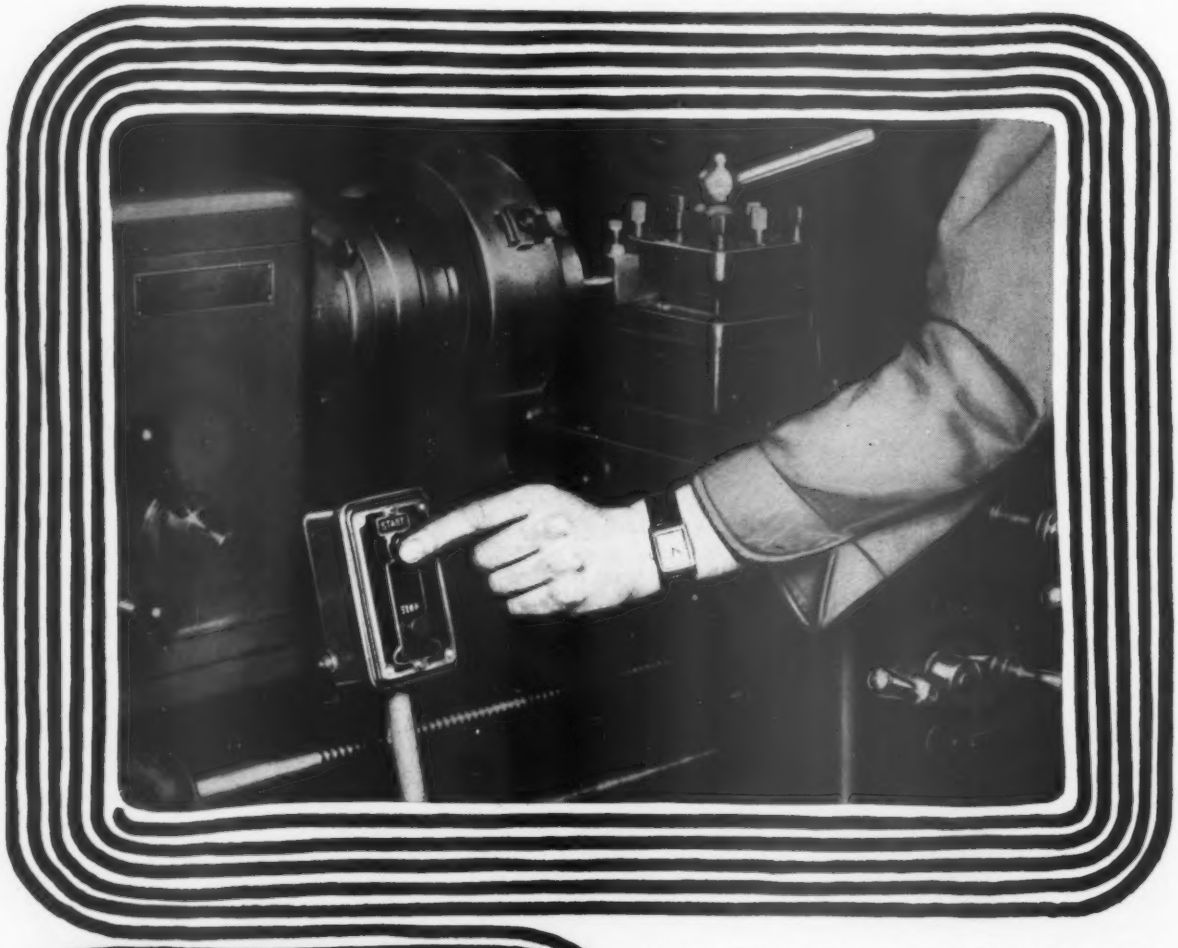

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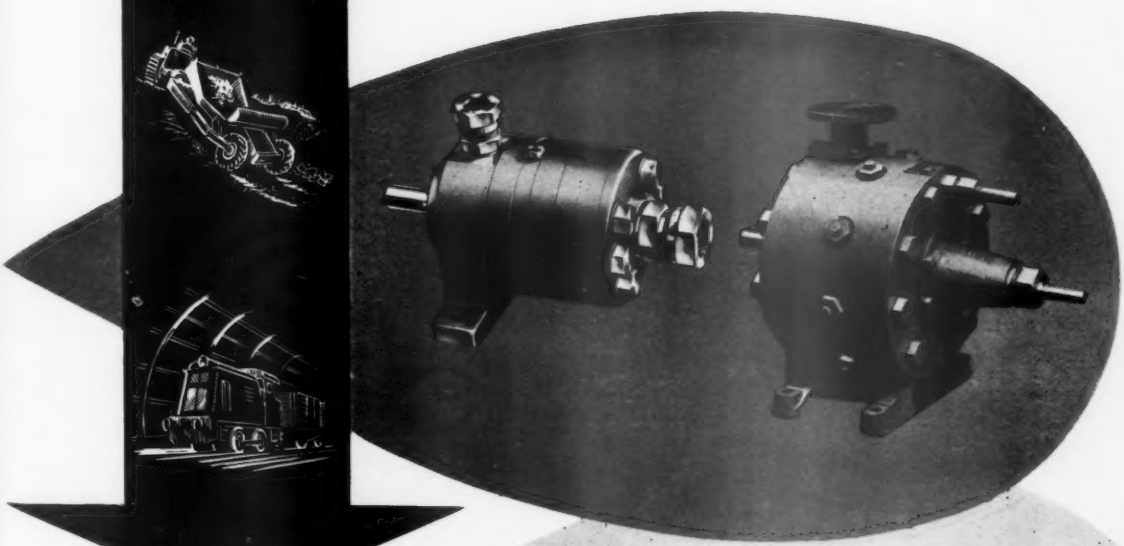

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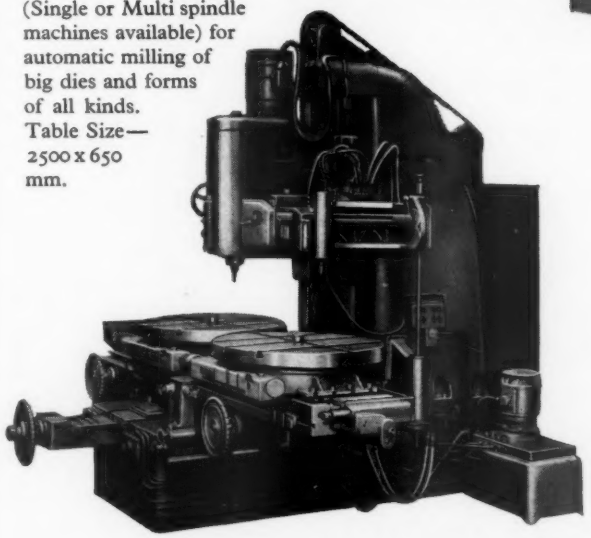

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Equipped with 3 Boring and Milling Heads. Table Size—1200 x 3000 mm.

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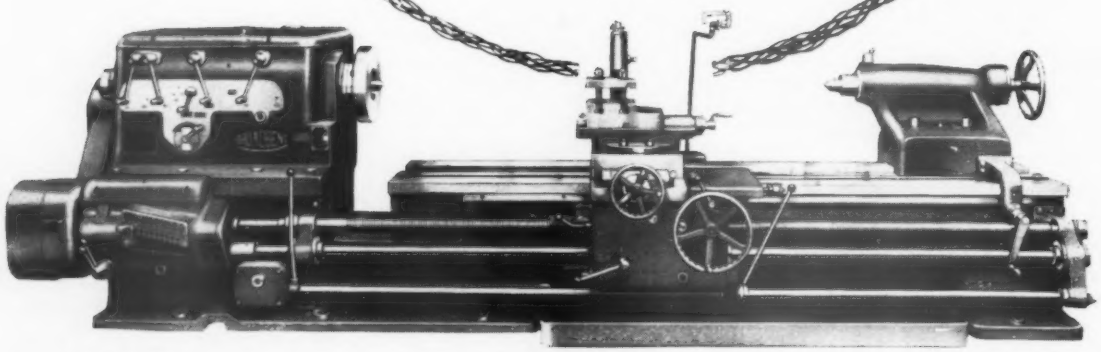
Write for descriptive literature on the full range of BROADBENT LATHES



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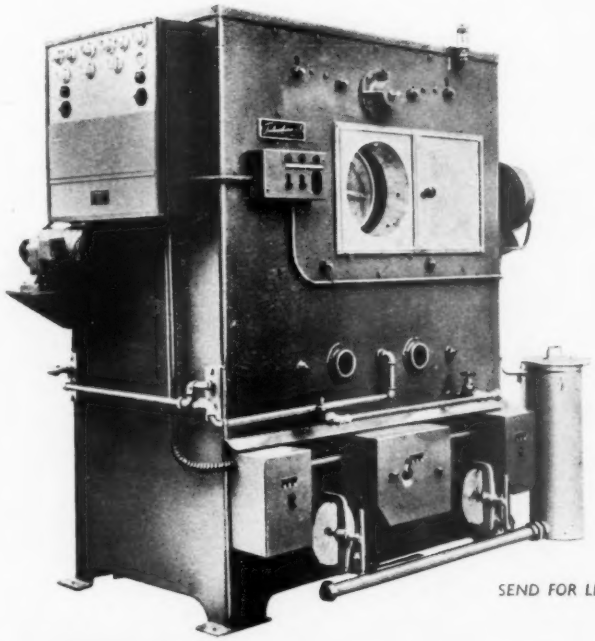
OF TRICHLORETHYLENE



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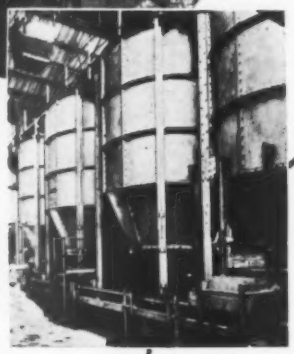
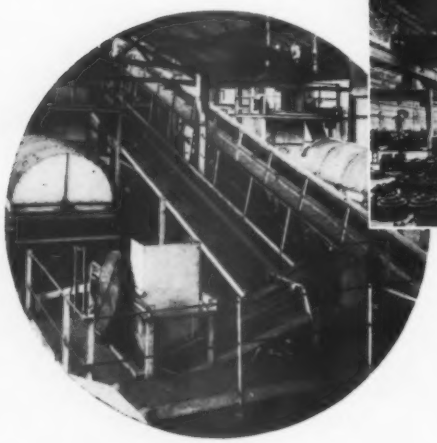


Sand Storage Hoppers

Roller Conveyor Systems

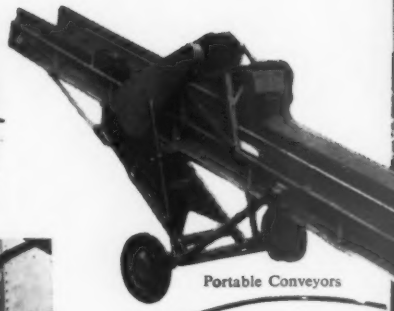


Overhead Travelling Cranes

Sand Conditioning Plant

Overhead Chain Conveyors

Pallet Conveyors



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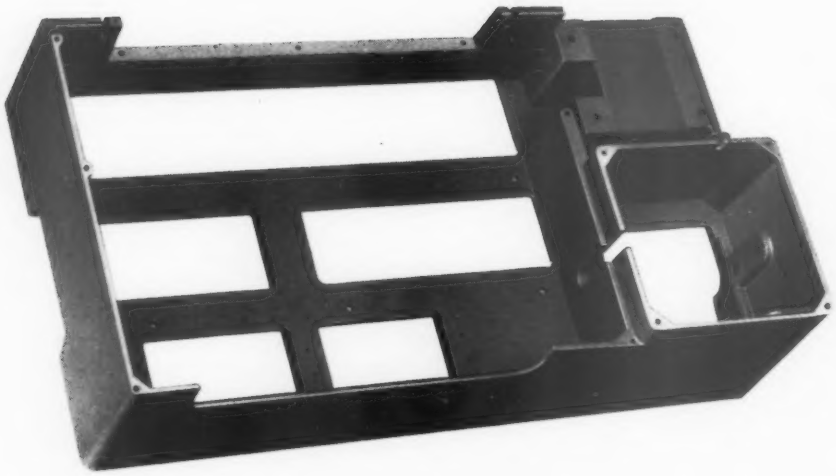
(IN MAZAK OF COURSE)



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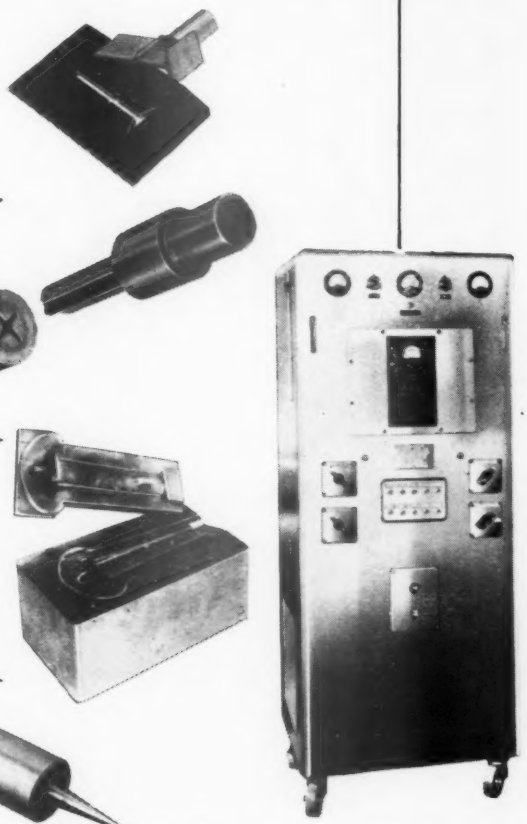

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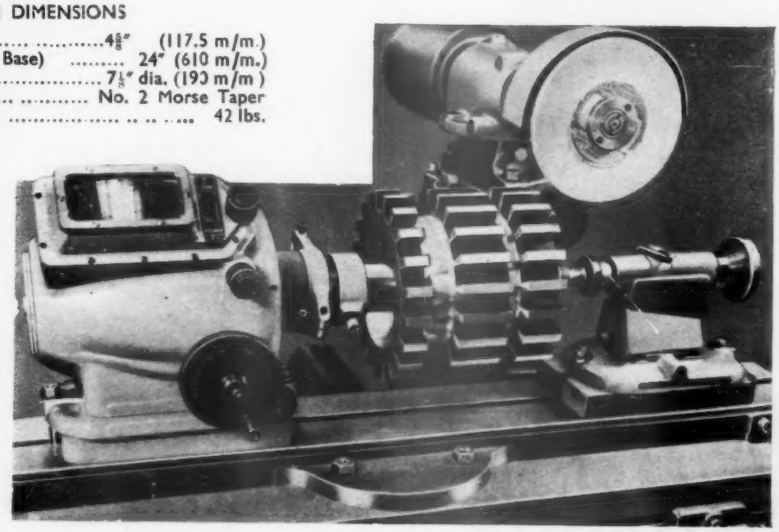

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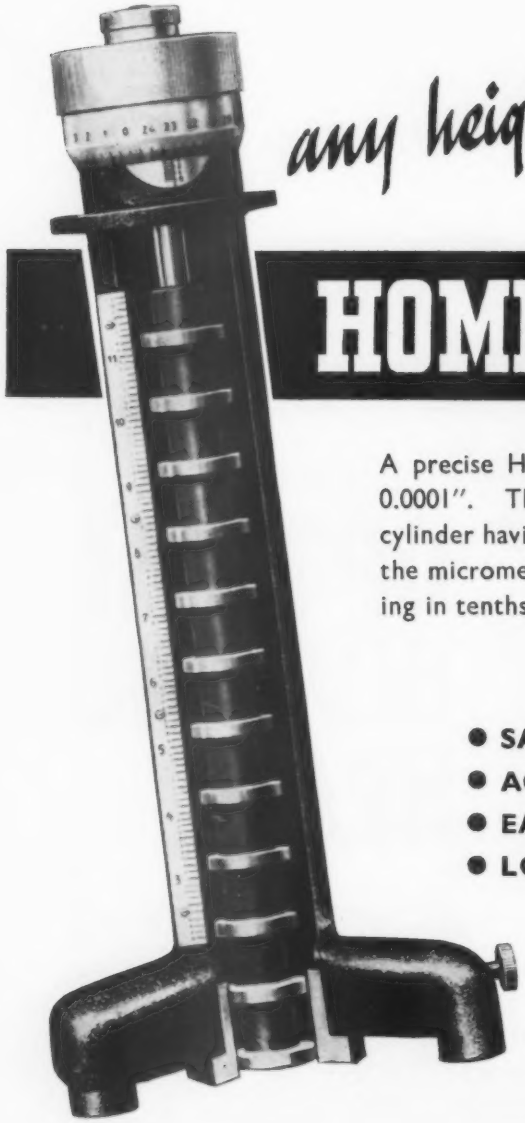

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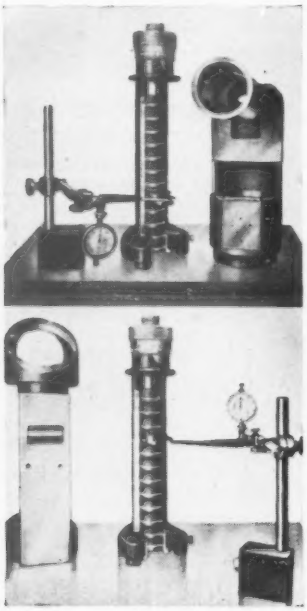

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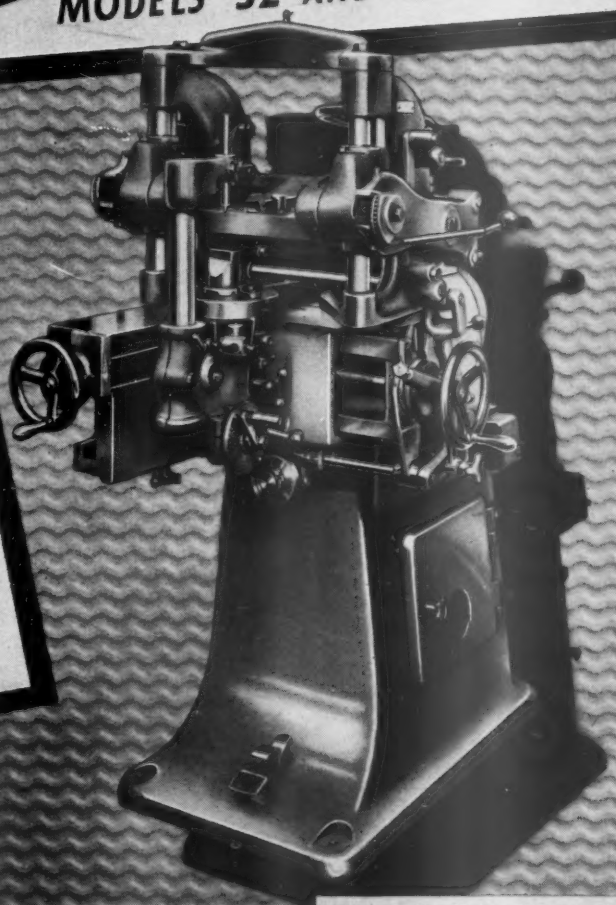

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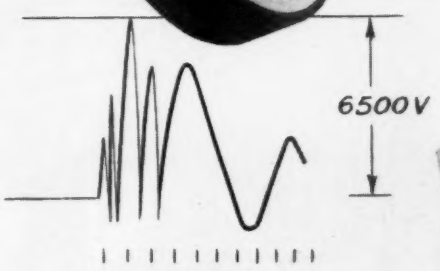
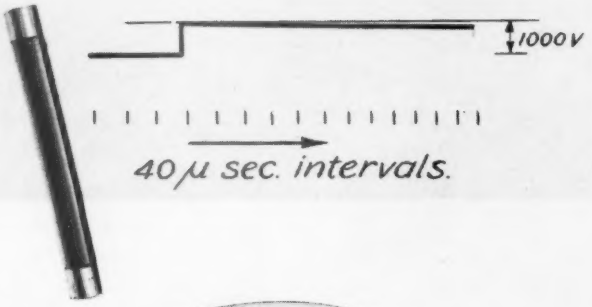
DH5

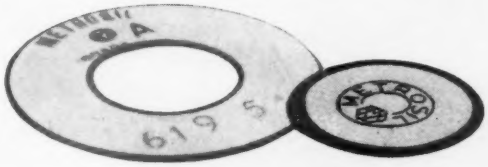
METROSIL

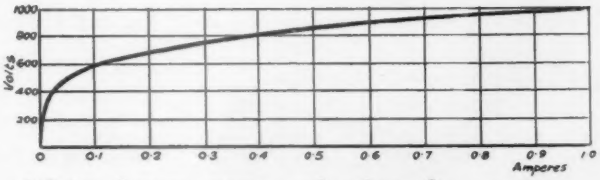
means protection against surge voltages





The non-linear volt-ampere characteristic of Metrosil resistors is exploited to provide a convenient means of safeguarding all types of electrical equipment against surge voltages. Based on silicon carbide, Metrosil is usually made in the form of discs, but rods can also be produced if required. These standard products are stable and convenient in size, standard discs ranging from $\frac{3}{8}$" to 6" in diameter. Typical applications for Metrosil products include the protection of field coils, relay coils and solenoids, instrument relays, condensers, tap-changing switches and power transmission lines. Other applications include spark quenching, protection of instruments under fault conditions, relay sensitivity improvement, etc. Please write for full technical details.





Relation between current and voltage for a typical "Metrosil" disc, examples of which are illustrated at the top of this page.

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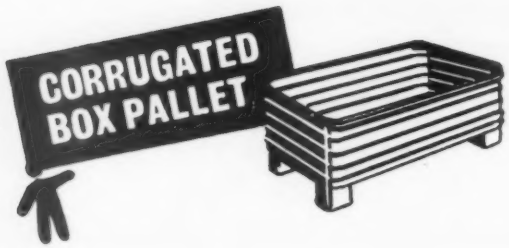

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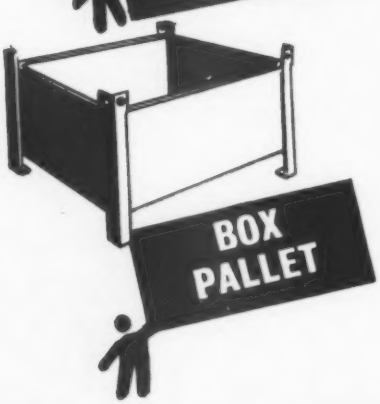

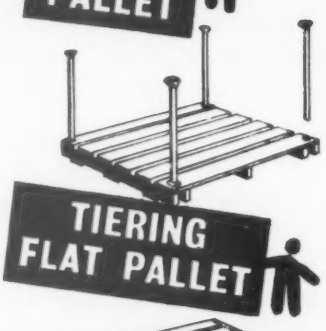

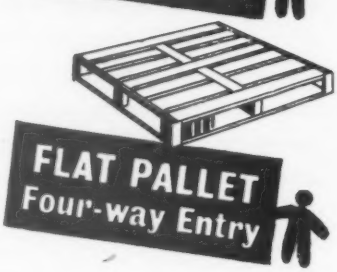

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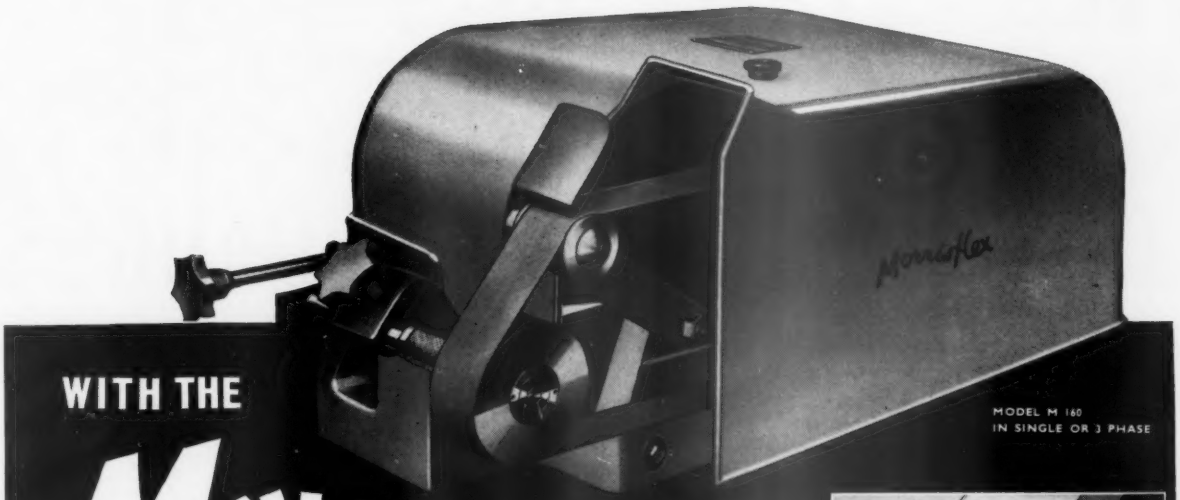

MODEL M 160
IN SINGLE OR 3 PHASE

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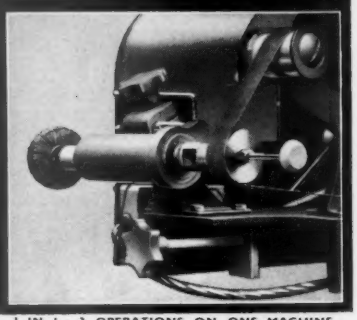

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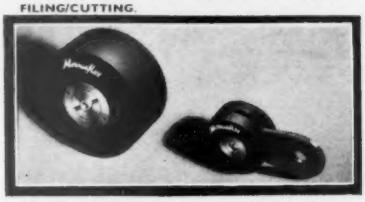

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ACCESSIBILITY TO CONTACT WHEELS
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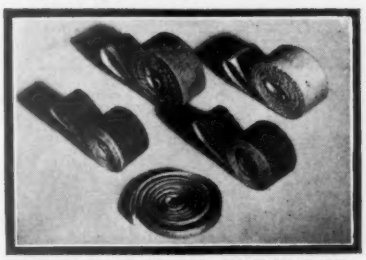

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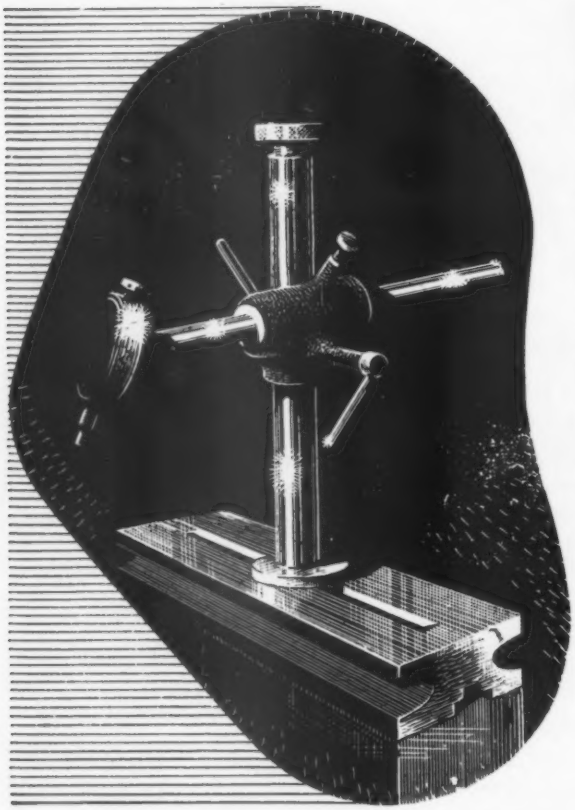

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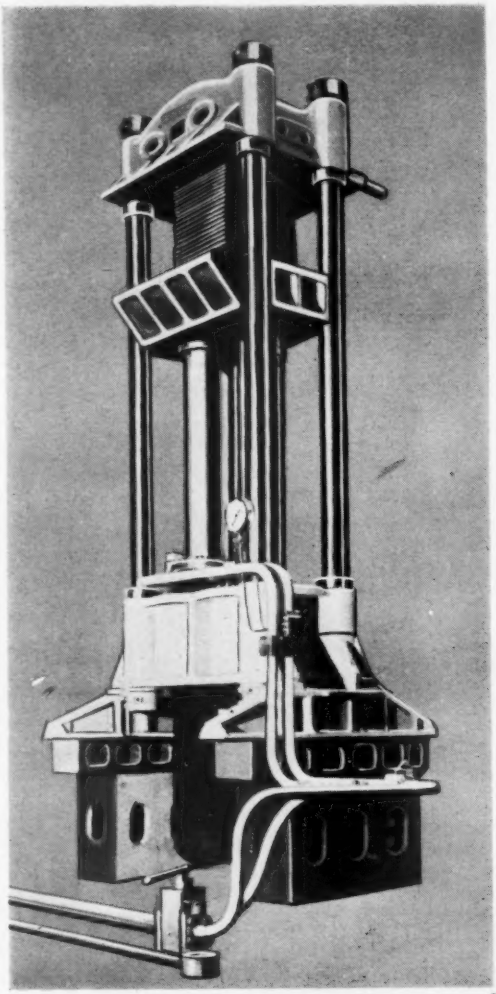

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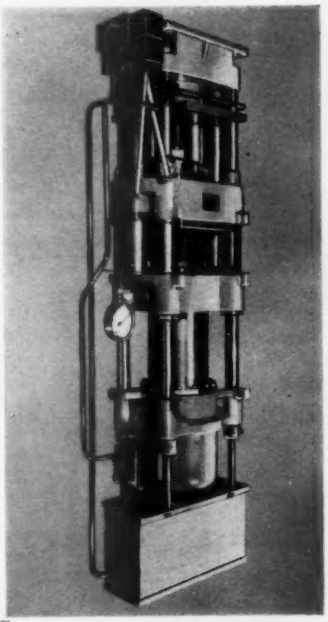
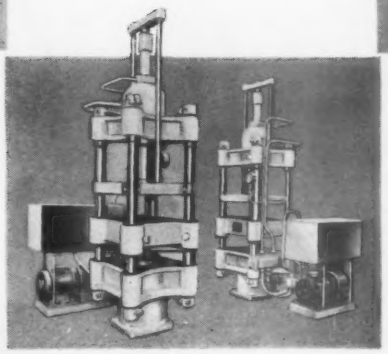
IF YOU have a pressing or baling problem you cannot do better than contact Fawcett, Preston & Co. Ltd. Our comprehensive range of hydraulic presses for all industrial purposes is backed by nearly two centuries of design and manufacturing experience.

Fawcett EST 1758

Left : A Fawcett double ram up-stroking 1135-ton baling press.

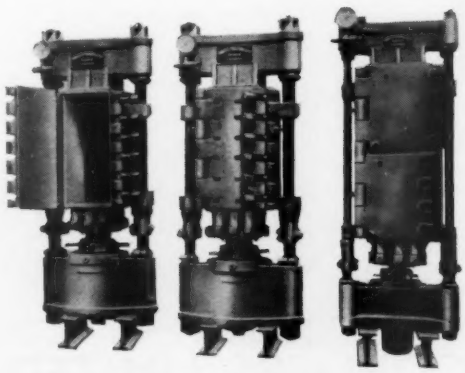
Right : A typical hydraulically operated, downstroking 100-ton plastic moulding press.





Left : Fawcett downstroking presses with nickel-coated main rams and adjustable table for daylight variation.

Below : Tobacco presses with locking device for retaining at fully pressed position.



Special presses designed to suit individual requirements

FAWCETT, PRESTON & CO. LTD. BROMBOROUGH CHESHIRE *PHONE : ROCKFERRY 2201 (5 LINES)*

Galtona O-K serrated blade CUTTERS

SPEED PRODUCTION
ON THE 'FAIREY' GANNET

Root wing end fittings for the 'FAIREY GANNET' . . . 98 ton tensile steel forgings . . . are milled economically with GALTONA O-K side and face cutters, as shown. The cutters are 9in. diameter by ⅝in. face, and each have 18 high speed steel serrated blades.

Whatever your milling operation, there are GALTONA O-K serrated blade cutters to do it better and faster. Full range of type and sizes with blabes of high speed steel, solid Stellite, or tipped with cemented carbide.

Richard Lloyd Limited

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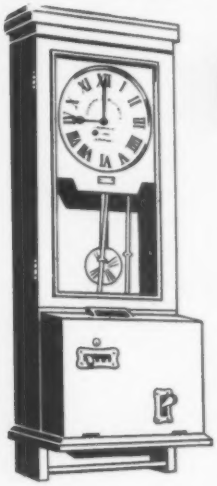
FOR TIME RECORDS AND COST CONTROL



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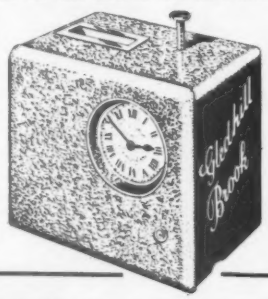
The Gledhill-Brook Company was intimately concerned with the earliest problems associated with the design and production of time recording machines. The first efficient electric-impulse recorders with accurate timekeeping independent of electric frequency or external influence were produced by Gledhill-Brook.

One of industry's urgent needs is the reduction of waste—especially the waste of time which costs money. That is where we are concerned and qualified to help. Our wide range of time-recording models covers most needs for the control of wages and labour.

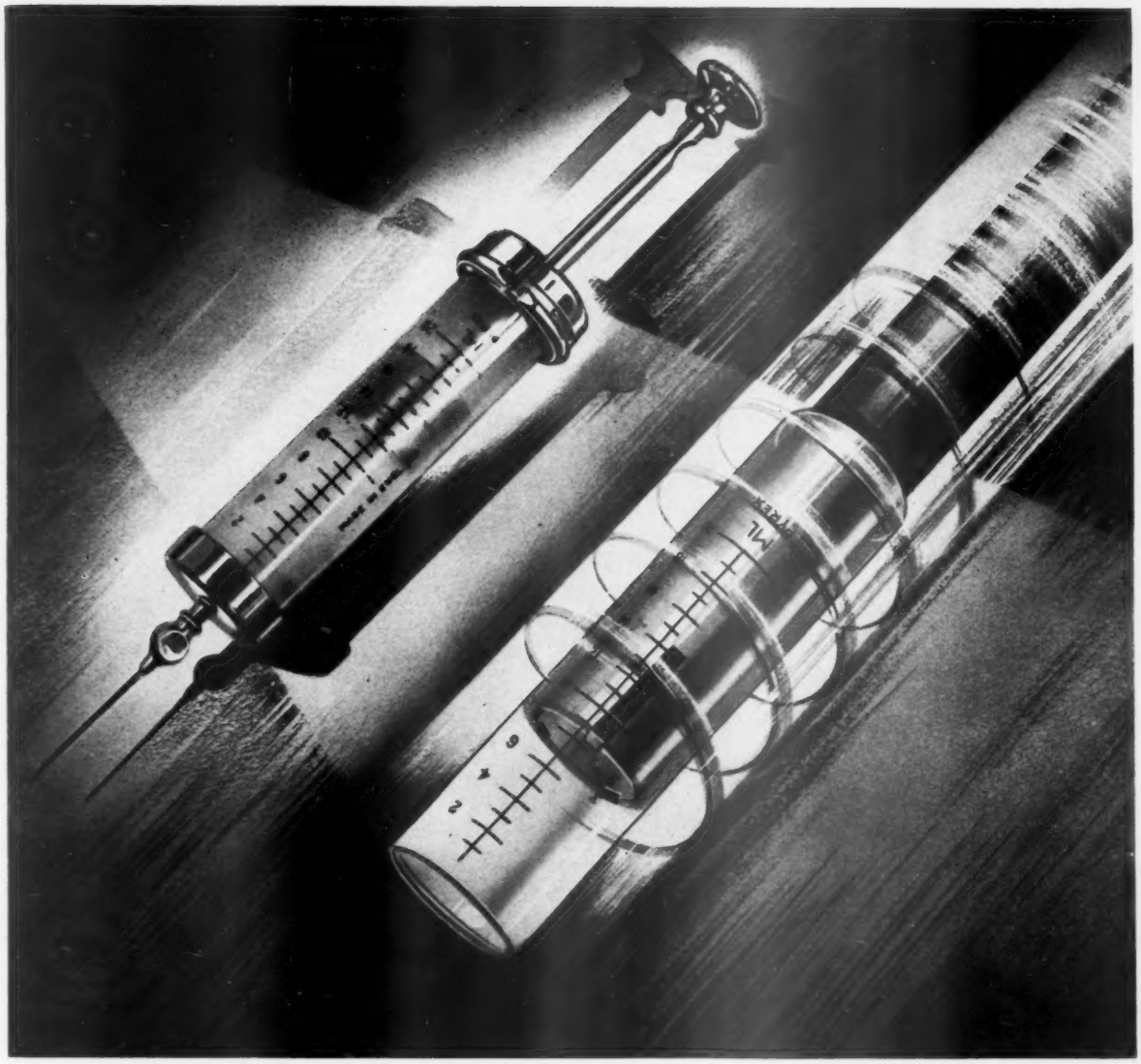
THE J.M.C. MODEL
SPECIALLY DESIGNED FOR SMALL STAFFS

This is a recent GLEDHILL-BROOK product. It records attendance times IN and OUT and job process times ON and OFF. It prints on the face of the card and requires the card to be headed on one side only. Fitted with patent Gledhill-Brook electrical movement, or with mechanical movement if so desired.

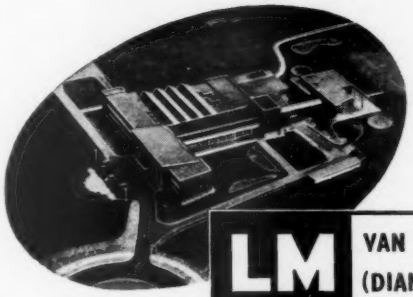
STEEL CASE
CELLULOSE FINISH



GLEDHILL-BROOK TIME RECORDERS LIMITED
20, EMPIRE WORKS HUDDERSFIELD



the medical diamond



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The accurate dispensing of liquids with the aid of a hypodermic depends on the accuracy and finish of the bore in the glass tube and its mating plunger. Diamond Powder is employed to obtain the desired finish and accuracy in the glass bore. In this as in many other operations, the very close grading of Diadust ensures high production rates with minimum scrap.

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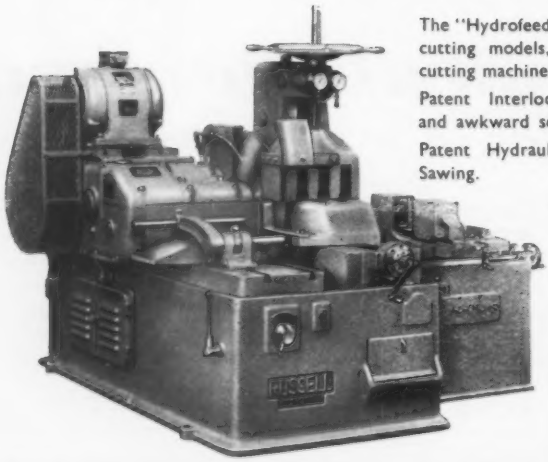
. . . twice as easy! with the PRIORITY PUNCH GRIP

The "PRIORITY" punch grip has been designed to avoid damage to the fingers of the punch user. It holds firmly all sizes of "PRIORITY" punches and allows a really hard blow to be struck without the risk of jarring.
The punch grip is strongly made in aluminium and is designed to sit easily in the hand.

EDWARD PRYOR & SON LTD
BROOM STREET SHEFFIELD

RUSSELL

METAL SAWING MACHINES



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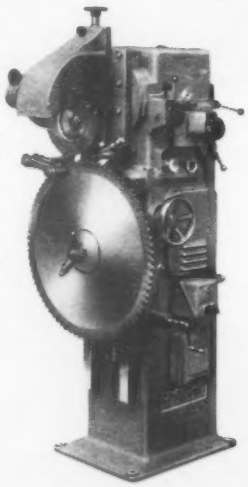
Patent Interlocking Vices can grip several bars and awkward sections.

Patent Hydraulic Circuit specially designed for Sawing.

Capacities up to 13½" diameter or 24" × 10" R.S.J.

'HYDROFEED' COLD SAWING MACHINE
Automatic bar feed.



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Capacity 11" to 48" blades

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is your best servant.

A machine tool is only as good as the oil that lubricates it. The choice of oil therefore not only determines the efficiency of the machine in operation, but also the length of its productive life.

Different types and parts of machine tools require different lubricants. Whatever the unit to be lubricated, there is an appropriate oil to be found in the Fletcher Miller range. The GENA section alone comprises seven oils graded in viscosity to lubricate all types of high speed spindles, plain bearings, headstocks, gear boxes and slideways. They all possess great film strength and exceptional powers of adhesion to metal. But machine tool lubrication is a specialist's job and maybe you need advice. If so, please call in one of our representatives; they are at your service whenever you need them.

FLETCHER MILLER *Machine Tool Lubricants*

FOR *correct* MACHINE TOOL LUBRICATION

VETA — FOR HYDRAULIC SYSTEMS GENERALLY

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Write today for a copy of our informative 20 page booklet, " Machine Tool Lubrication ".

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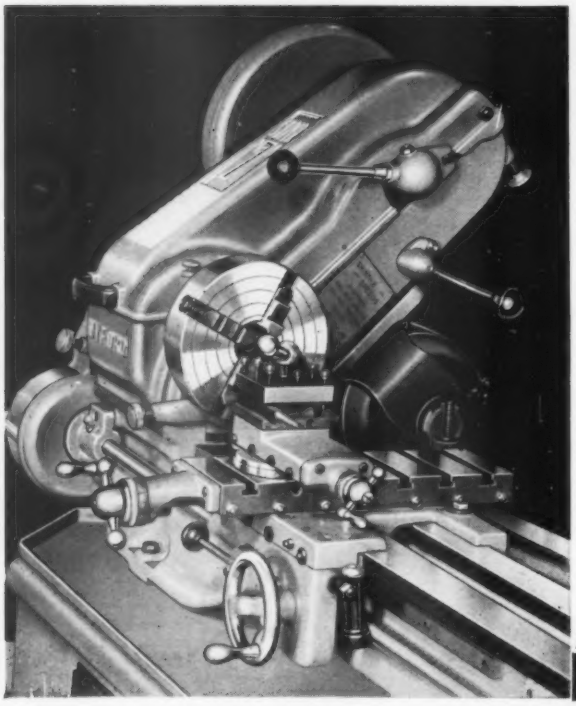
MTL 24

—A HIGH SPEED LATHE—



2,000 RPM PLUS

- Fourteen Spindle Speeds from 25-2180 r.p.m.
- Clutch Control to Drive Unit
- Large Boring Table, to carry Rear Tool Post
- Attachments for Taper Turning, Dividing, Milling, Repetition Turning, etc.

3½" CENTRE HEIGHT 19" BETWEEN CENTRES

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HIGH-SPEED LATHE

Full details from:-

MYFORD ENG. CO. LTD. BEESTON, NOTTINGHAM, ENG.

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The characteristics of steel tubes are better than solid sections. Steel tubes save weight and save machining and other production time. They are available in a vast range of sizes and in many different steels, and Accles & Pollock's knowledge and experience is freely at your disposal to help you make the best use of them.

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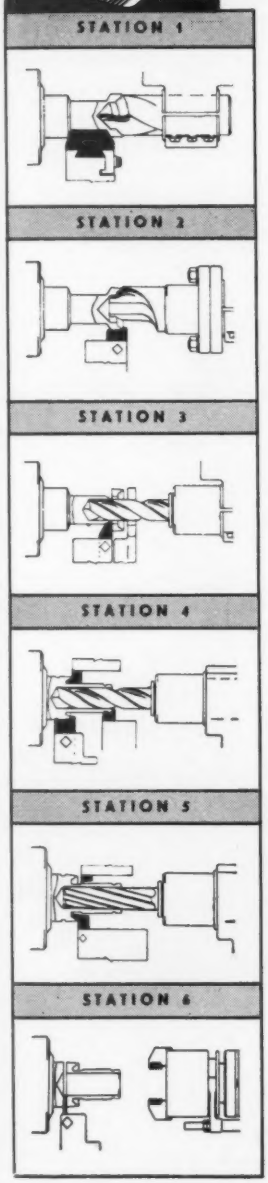
Makers and manipulators of precision tubes in plain carbon, alloy and stainless steels, and other metals. Largest stocks in the country.

TBW/81

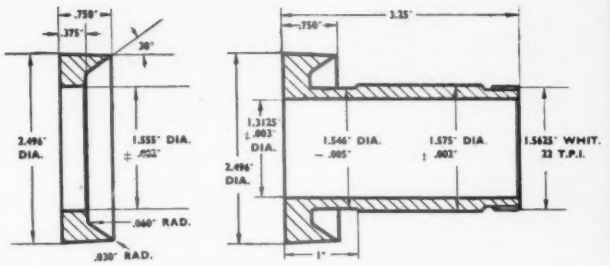
Another user gets an output bonus!

TWO PARTS produced together on the Wickman Multi-spindle Automatic

in 91 seconds

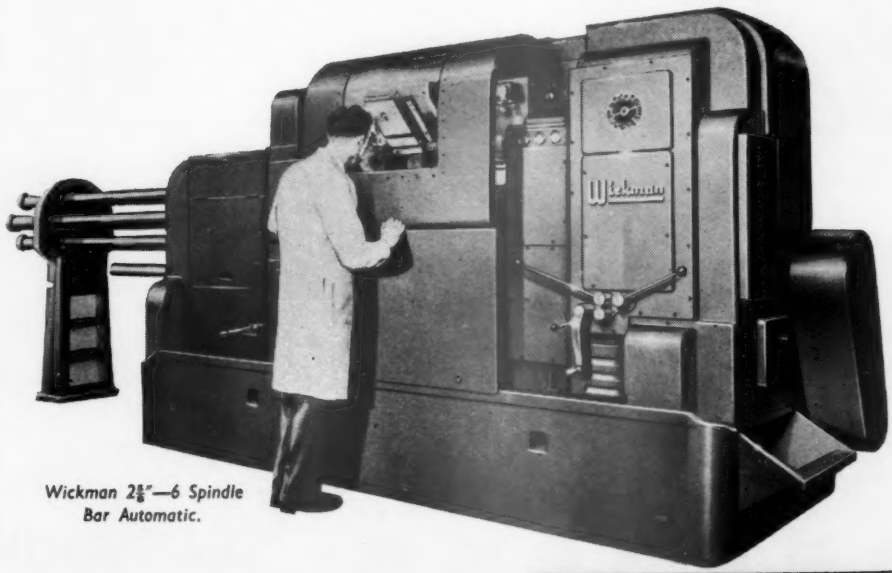


Commutator Hub and Clamping Ring (Mild Steel).



So often the production engineer thinks in terms of one part, and one machine to make it . . . and although it may be the exception rather than the rule to make two parts together on a Wickman Automatic, this example demonstrates the outlook of Wickman Engineers in planning for maximum machine utilisation, and the exceptional tooling opportunities offered by the range of Multi-spindle Automatics.

Whether you're looking for higher output, or putting new parts into production, it will pay you to let Wickman engineers investigate the possibilities of tooling up a Multi-spindle Automatic to meet your requirements. Remember, there are no expensive interchangeable cams to design and make; by means of the Wickman patent autosetting mechanism all tool feed strokes and bar feed can be set in a matter of minutes, and a wide range of standard attachments is available.



Wickman 2⅝"—6 Spindle Bar Automatic.

WICKMAN *of* COVENTRY

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Wickman

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if it's a good file it's a

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COSSOR *presents...*

The new Cossor Double Beam Oscillograph

MODEL 1052

Two similar amplifier channels with an approximate gain of 2000 and an upper frequency response of 5 megacycles (–6DB) are features of this new Cossor Double Beam general purpose oscillograph. The repetitive or triggered time base has a sweep duration from 200 milliseconds to 5 microseconds.

The instrument will operate from power supplies of any of the various frequencies and voltages encountered in the Armed Services or from standard civil supply mains. The top and side panels are quickly detachable to allow inspection and a removable plate at the rear of the instrument allows access to tube plates, anode and modulator.

and Voltage Calibrator

MODEL 1433

Primarily designed to be used with the new Cossor oscillograph the Cossor Voltage Calibrator model 1433 provides an accurate means of calibration of input voltages to the plates or amplifiers of any oscillograph. Calibrating voltages are read directly from a wide scale meter without any computation being necessary. Measurements can be made to an accuracy of ± 5% and the instrument can be used in any application where a source of accurately-known voltage is required.

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GASCOIGNE'S

KEE KLAMP

(Registered Trade Mark)

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When storage is a problem call in the specialists. "Kee Klamp" racking with "Kee Board" staging provide the complete answer to efficient utilisation of space.

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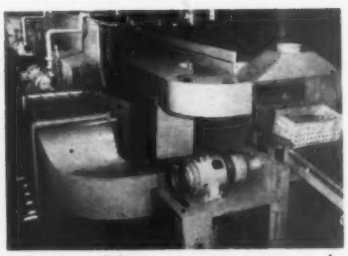
Kee Klamps also make cycle racks — works benches — machinery guards — assembly benches, etc.

Bratby

HERE ARE THREE EXAMPLES

INDUSTRIAL CLEANING MACHINES
can be designed to meet your particular cleaning problems

This illustration shows a machine cleaning crank cases in the production line. It is equally capable of cleaning small parts in baskets.



A power driven conveyor system is employed with this cleaning machine for ball bearings.

Trays carrying the work are pushed through on a roller conveyor by hand in this cleaning installation.

Whilst offering a very wide variety of standard cleaning equipment, it is BRATBY policy, wherever possible to design the machine to meet the particular cleaning problem. Careful study of each individual problem ensures maximum efficiency and economy of the plant in operation. The illustrations show but a few of the specific types of Cleaning Machines designed by BRATBY for individual needs.

Designed and Manufactured by **BRATBY & HINCHLIFFE LTD · SANDFORD STREET · ANCOATS · MANCHESTER 4**

SOLE AGENTS FOR GREAT BRITAIN

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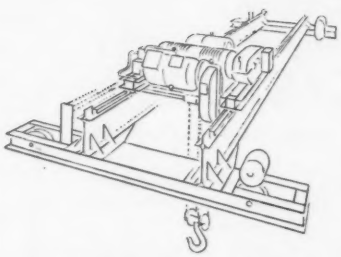
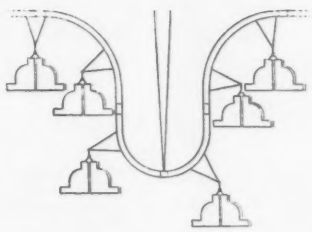
A KING *Marvex Electric Pulley Block in use on an overhead runway system.*

Call in KING . . . and get things moving!

★ **Electric Pulley Blocks** single or double speeds to lift 100 lbs. to 10 tons ★ **Overhead Runways** ★ **Overhead Conveyors** to carry up to 1 ton per trolley ★ **Slat, Belt and Roller Conveyors**—to handle ounces or tons ★ **Cranes** to make loads of up to 200 tons a push-button job ★ Austin, Dunlop, Frigidaire, Hoover use KING handling gear. Find out how KING can help you—write for illustrated booklets.



A KING *electric overhead crane*



A KING *overhead chain conveyor in action*

KINGS STRENGTHEN YOUR HAND

KING

REGISTERED TRADE MARK

CONVEYORS · CRANES
PULLEY BLOCKS

Covered by British and Foreign Patents

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Unique

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

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It is particularly suitable for shouldered work.

Send today for descriptive leaflet.

why pick on us?

Because this vacuum cleaner fan motor housing really is the cat's whiskers. It's light (for the housewife's sake), and strong (to protect the mechanism that goes inside). And we cast the whole complicated thing in one simple operation, by pressure die casting. Can you think of a better way of doing it?

the whole in one

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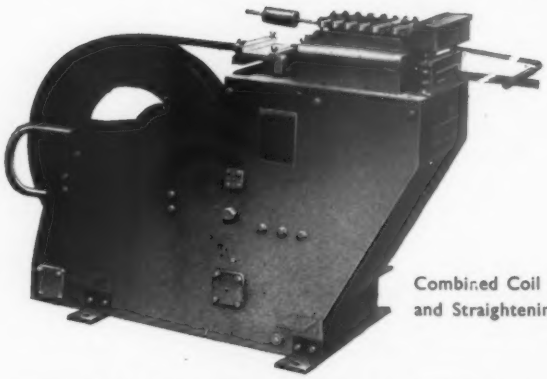
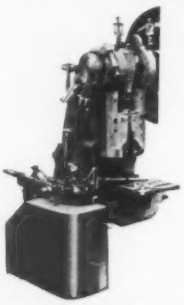
CRC 24

HIGH SPEED PRESS OPERATIONS

Strip Straightening Machine



Combined Coil Cradle and Straightening Machine

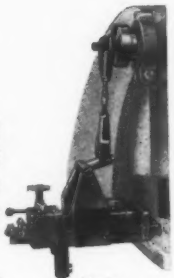


Mechanical Hand Feed for second operation work

Motorised Coil Holder or Scrap Winder

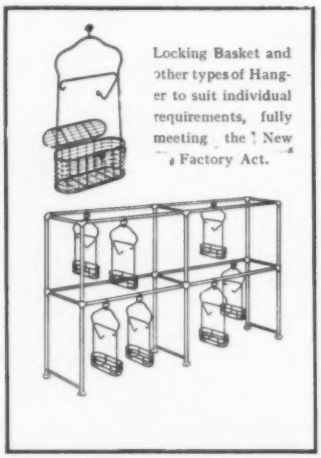
Mechanization of the Press Shop occupies the mind of all forward thinking directors and planners. Our range of equipment is designed for working with or attaching to existing plant. It includes coil holders, straightening rolls, strip wipers and lubricators, strip feeds, scrap cutters and winders —and Mechanical Hands for feeding second operation work.

Our Technical Staff is available to advise you — Illustrated literature FREE on request



Strip Feed

PRESS EQUIPMENT LTD., HUNTERS VALE, BIRMINGHAM, 19. Phone: NORTHERN 4823



Locking Basket and other types of Hanger to suit individual requirements, fully meeting the New Factory Act.

Permanent Exhibit at Factory, Health and Welfare Exhibition, London, S.W.1.

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THESE AIR-DRY "SIEBER" HANGERS ARE A TREAT

"At last I can change into dry uncreased clothing when I go home! It's plain commonsense to hang rain-soaked 'togs' on a **SIEBER** Hanger instead of bundling them into an unventilated, smelly locker. It saved me from many colds and my clothes are fresh and wear better. The boss, too, must like these **SIEBER** Hangers because they reduce absenteeism and the space he saves is bound to repay the little money they cost. Repair costs? Not on your life, because this Hanger Equipment is made to last for good and all."

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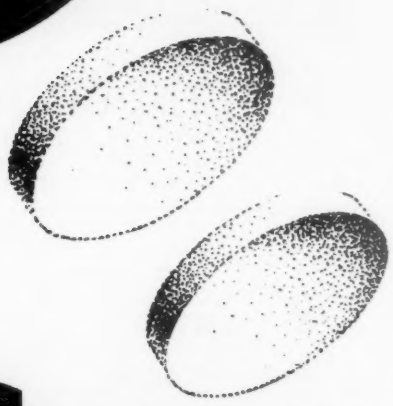
NEVEN TOOLS

speed the job!



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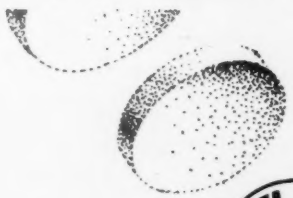
With a 'Neven' Drill, we have trepanned over 5,000 accurate test pieces from hard refractory materials.

Over Twenty years ago *Mr. Neven introduced his Impregnated Diamond Tools. Great technical advances have been made in succeeding years and production is still under the personal supervision of Mr. Neven. Our latest catalogue gives the widest range of Diamond Tools yet listed for working tungsten carbide, glass quartz, stone, ceramics and hard refractories, etc.*

Keep right up to date by sending for a copy today.



NEVEN

IMPREGNATED DIAMOND PRODUCTS LTD · GLOUCESTER

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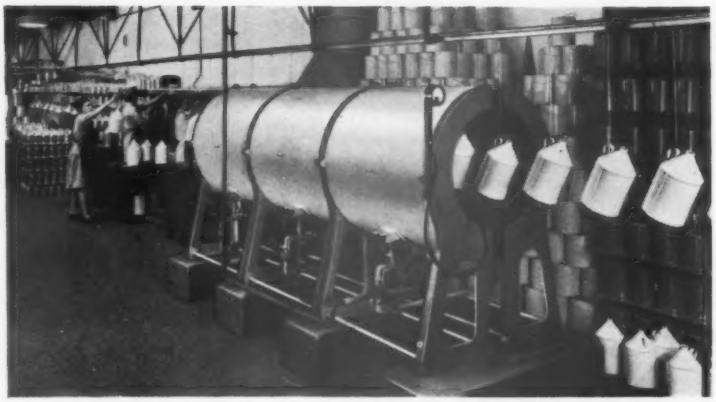
. . . but you can get a far better finish

with GAS INFRA-RED



GAS INFRA-RED installations by Parkinson and Cowan not only speed up the rate of drying but ensure a better finish at the same time.

Our illustration shows tinplate cans being dried in 1½ minutes by three 2 ft. diameter Gas Infra-Red tunnel units with a torsional type conveyor. These tinplate cans emerged with a finish unobtainable by any other means in so short a space of time.

Put GAS INFRA-RED to work in *your* factory. We shall be glad to let you have full details.

PARKINSON AND COWAN INDUSTRIAL PRODUCTS

(A DIVISION OF PARKINSON AND COWAN LIMITED)

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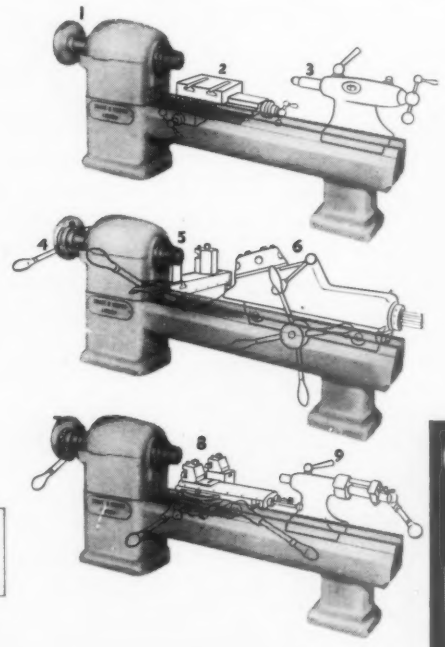
Sixteen standard combinations available.

All attachments interchangeable.

4" height of centres. Collet capacity with P.L.H. and P.R.H. headstocks: ¾" diameter. P.D.H. headstock 11/16" diameter, dead length collet.

Ask for illustrated catalogue G1/2/48.

from toolroom to production...



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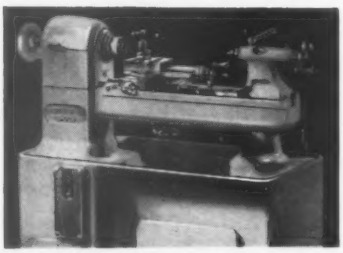

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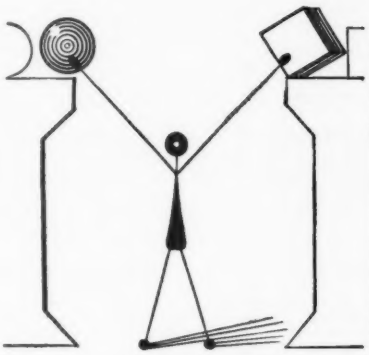
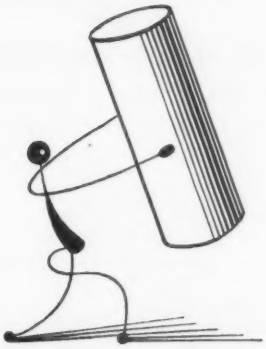
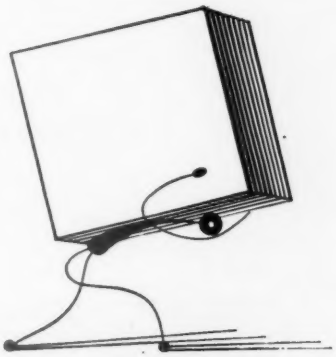


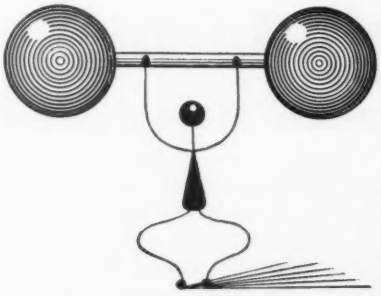
...reach...



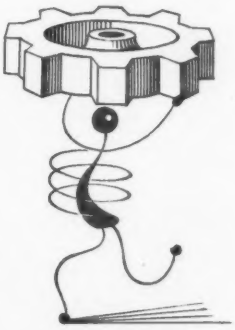
...grasp...



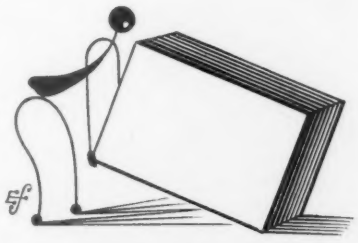
...carry...



...lift...



...turn...



...tilt...

... roll, dislodge, clean, sort, shelve, clamp and feed parts. Hymatic Automation is thus invaluable in the automatic and selective transfer of parts from one process to the next, from conveyor to conveyor; in unloading one machine and loading the next; or in quick clamping to hold parts during machining. All designs in Hymatic Automation are made for specific tasks, but are readily adaptable to others.

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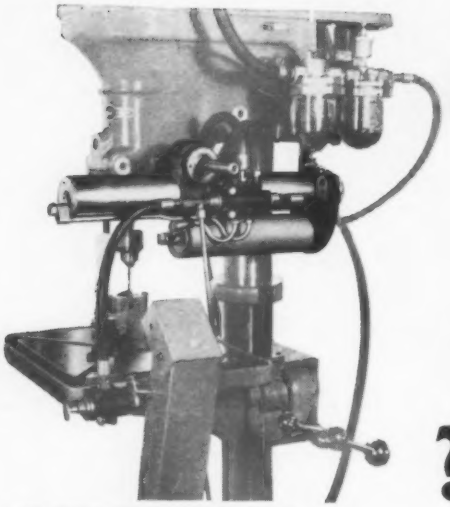

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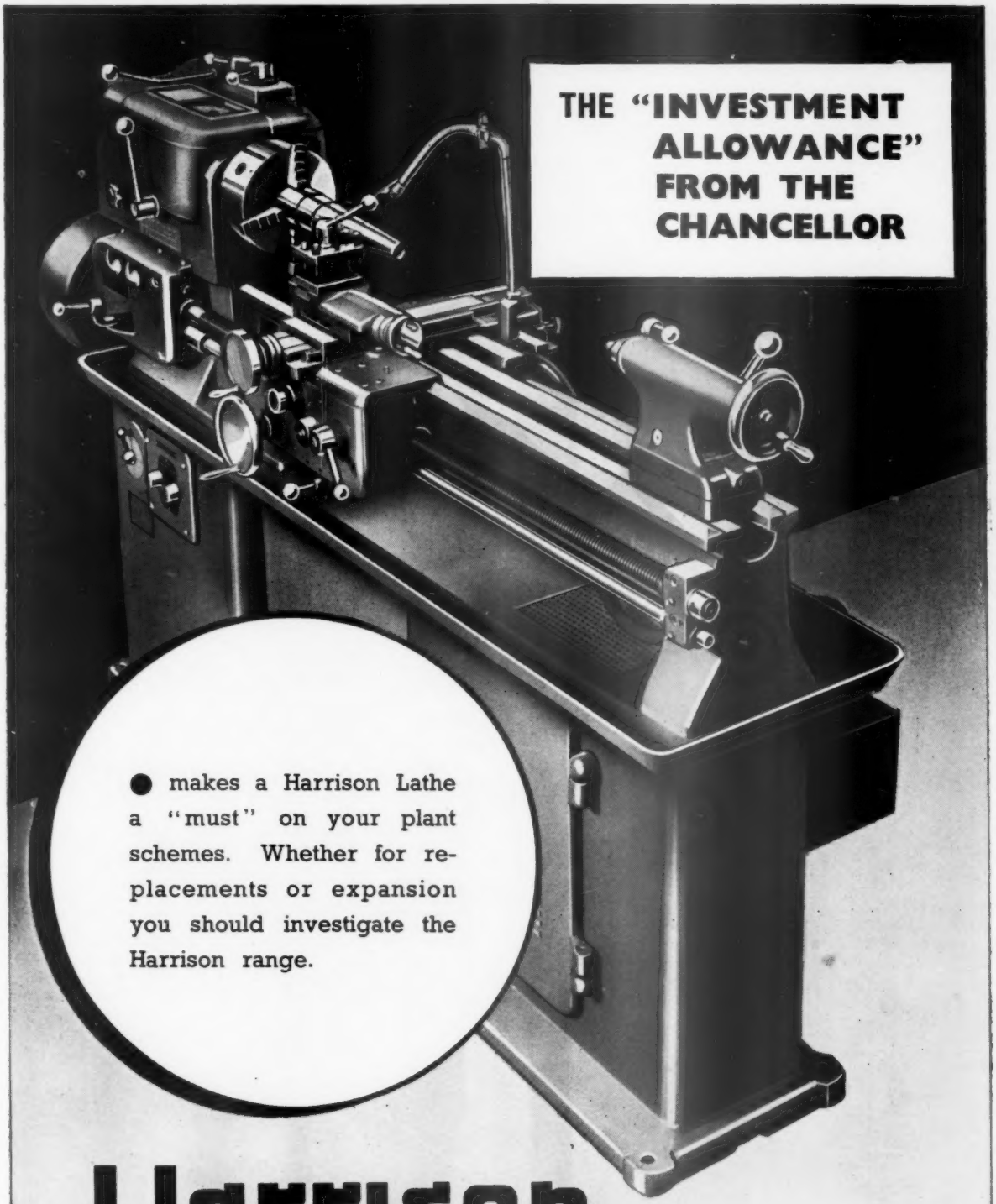

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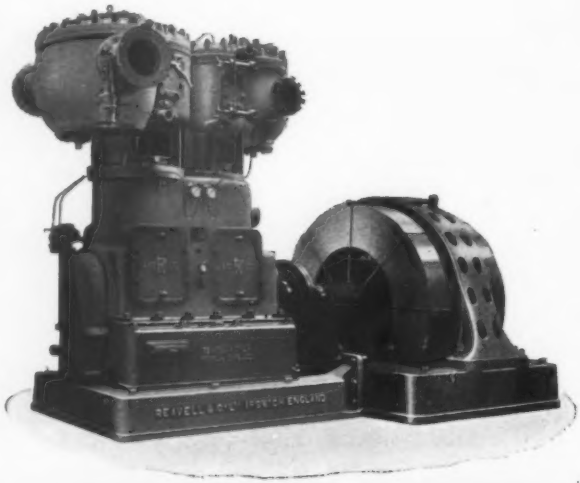

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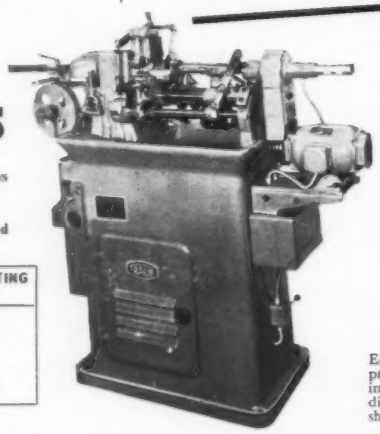

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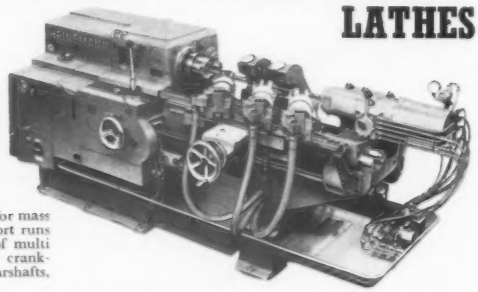

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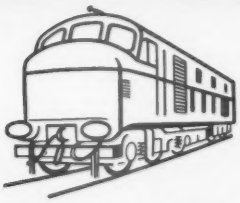
THINK ZINC



Using die cast zinc alloy means faster production! This instrument container is made by the zinc alloy die casting process — the high-speed production method that more and more industries are adopting. Zinc alloy die casting has other outstanding advantages as well. They are :

SCOPE FOR DESIGNER · EXTREME ACCURACY · GOOD CORROSION RESISTANCE · STABILITY
STRENGTH · LONG LIFE OF DIES · LITTLE NEED FOR MACHINING · LOW UNIT COST

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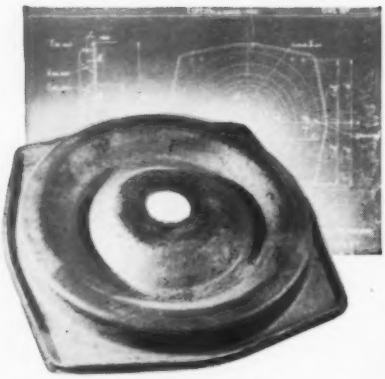
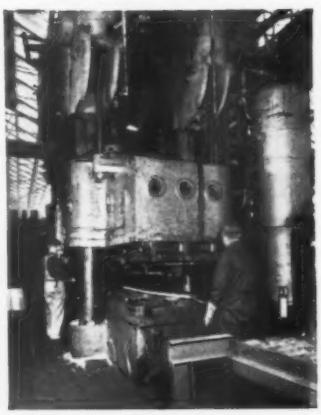


Strength
Weight
Shape

Skilled manipulation of flat steel sheet in modern power presses by means of expertly contrived dies is a process of manufacture which holds out enormous possibilities to the Designer and to the Production Engineer.

A steel pressing has a remarkably high strength to weight ratio; it can be die-formed to the required shape by one or a short series of pressing operations, with very close dimensional accuracy; and large or small numbers of parts can be produced economically, often at a cost lower than would be practicable by any other process of manufacture.

We are shortly to publish a series of leaflets illustrating pressings in current production as an indication of our capacity and of the facilities that this particular manufacturing process provides; *copies will be sent to all interested Engineers and Designers who will let us know that they would like their names to be included on our mailing list for these leaflets.*



This 2000 ton mechanical press can produce cold pressings up to 25 feet in length and between $\frac{1}{32}$" and $\frac{1}{4}$" thick according to the area of the component. The press is fitted with hydro-pneumatic die cushions. Here it is producing half sections for chassis side box members, two at a time.

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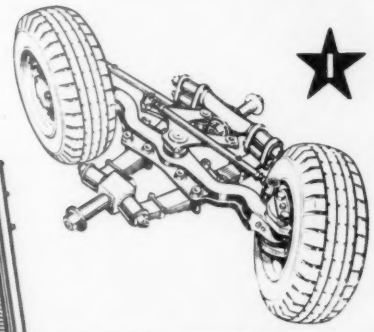

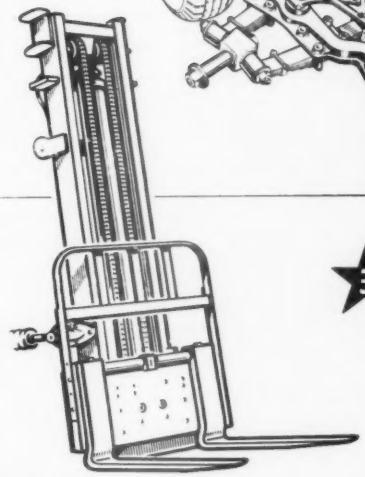

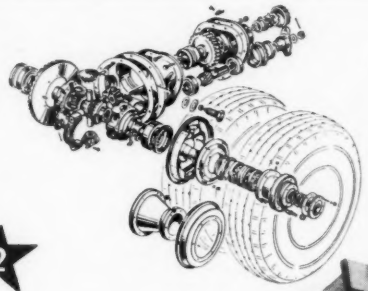

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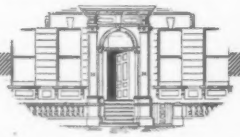

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Parts Oversize for Comparator Checked With This Fixture
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THE MACHINIST

79 SUBJECT CLASSIFICATIONS

In the fifty-two issues of Volume 97 (January to December 1953) articles were published under no less than 79 main subject classifications; in addition, news and views from 30 overseas countries were reported upon while the regular features included, amongst others, BUSINESS OPPORTUNITIES, TRADE NOTES and INDUSTRIAL NEWS REPORT.

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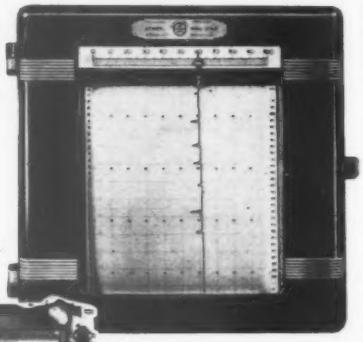

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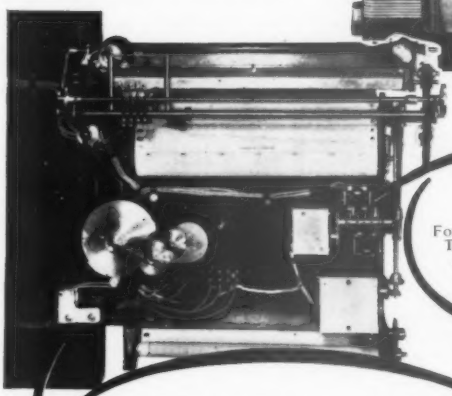

Four Burgess Micro Switchettes, Type V3 fitted with auxiliary roller actuators type VLR1. They switch over two thermo-couples to the amplifier circuit.

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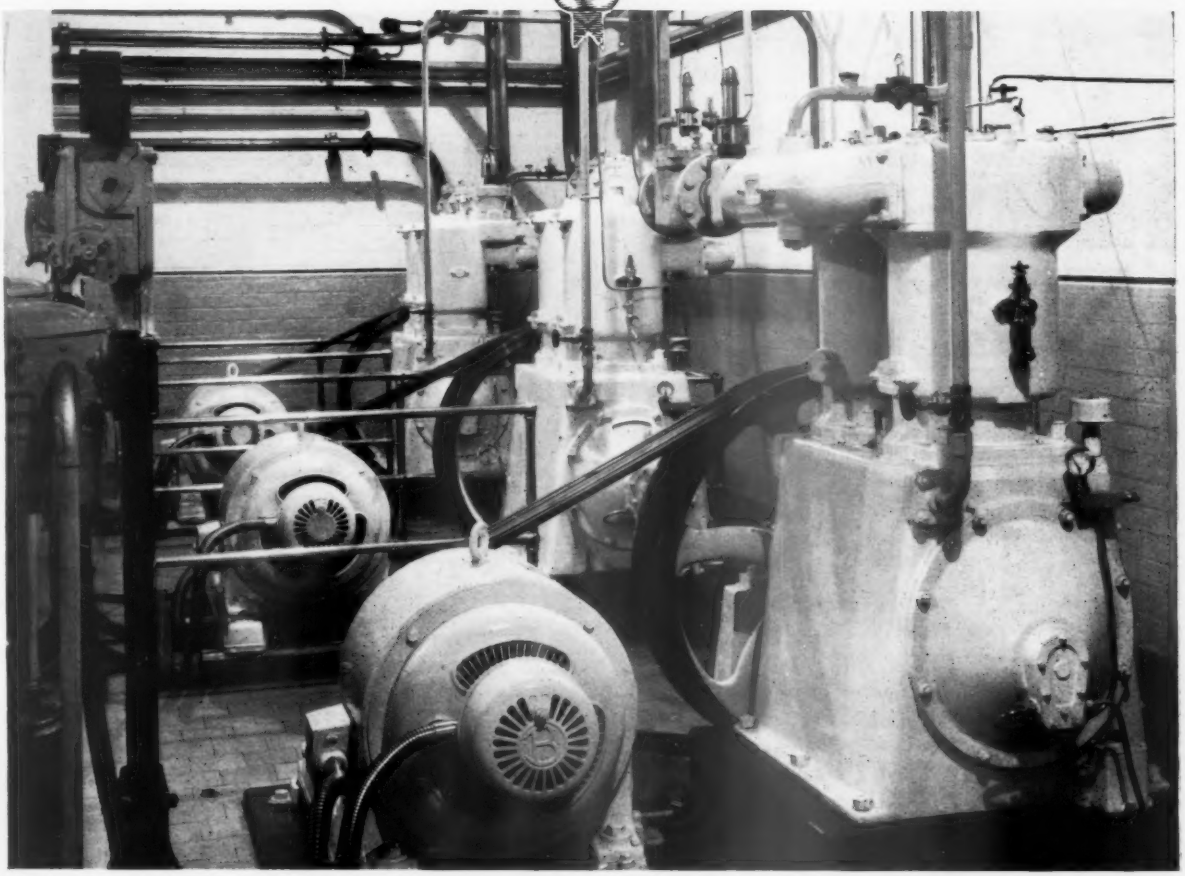

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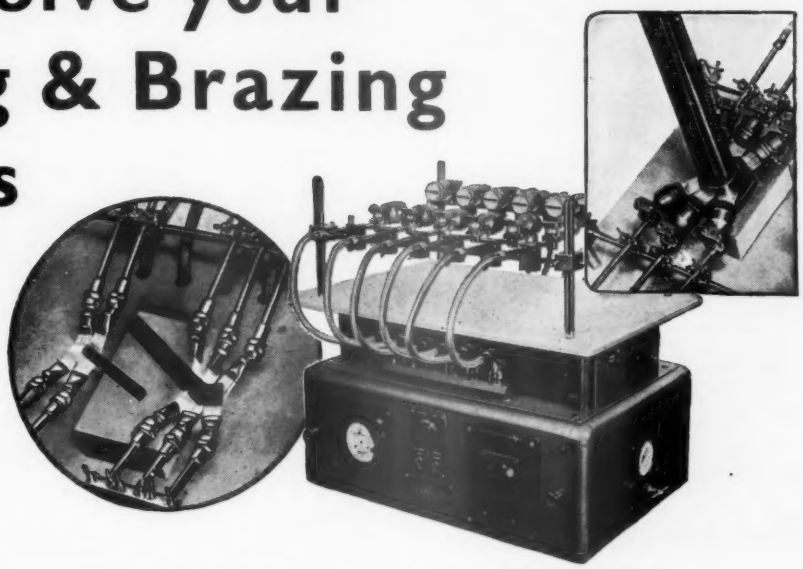

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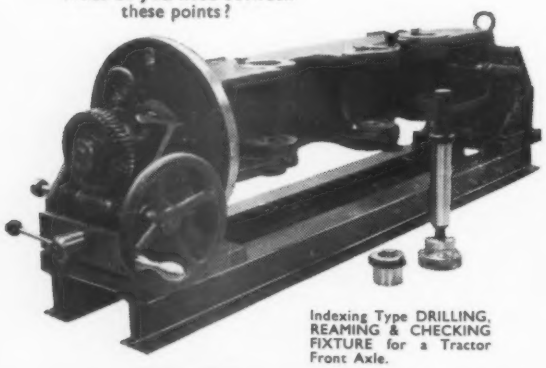

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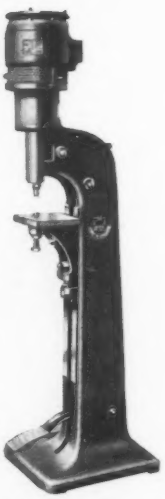

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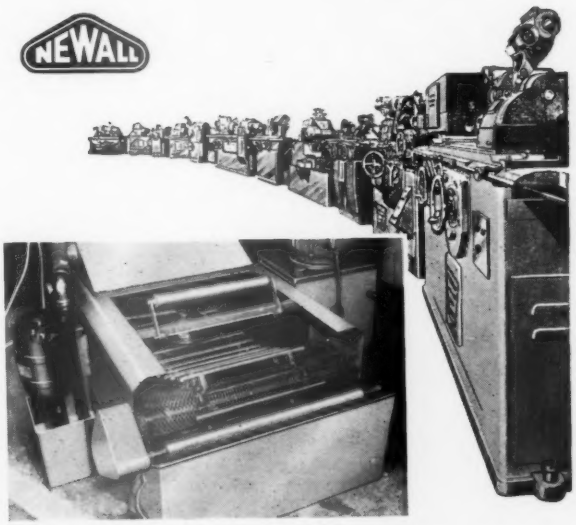

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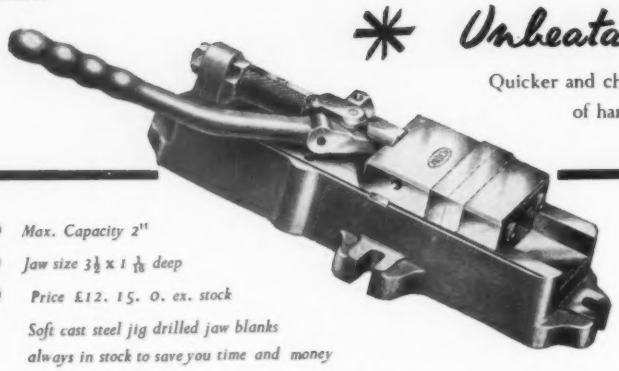

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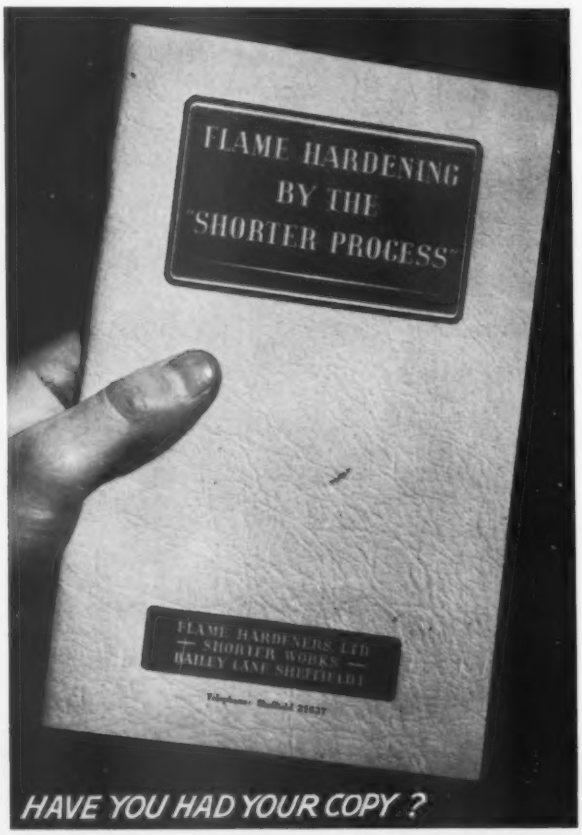

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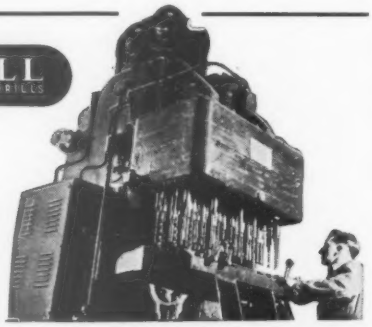

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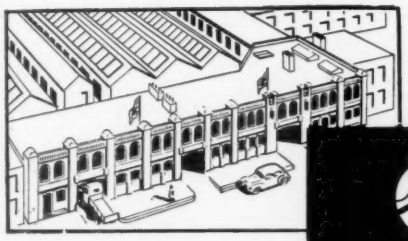

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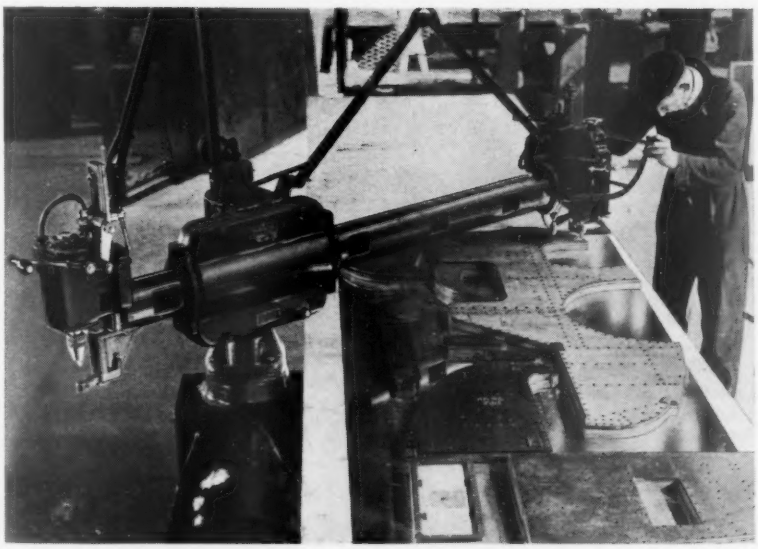

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JOURNAL SUPPLEMENT

Vol. 33, No. 7
July, 1954

INSTITUTION OF PRODUCTION ENGINEERS, 10, CHESTERFIELD ST., LONDON, W.1

1954 SUMMER SCHOOL

Preliminary details of the Fifth Annual Summer School, to be held at Ashorne Hill, Warwickshire, from 25th to 29th August, 1954 are now contained in a separate leaflet enclosed with this Supplement. A form of application is attached to the leaflet. *Those who intend to be present are advised to make early application, since the number of vacancies is strictly limited.*

LIBRARY CATALOGUE

The Library Committee announce that work on the catalogue of the Hazleton Memorial Library is now nearly completed, and that it should be in the printer's hands by the end of the month. It will be a book of some 250 pages, and will contain details of approximately 3,000 items, arranged alphabetically by subject, with an author index. It is proposed to make a charge of 2/6d for this publication.

In order to assess printing requirements, it would be appreciated if members who will require copies of the catalogue would complete and return the order form overleaf. Please do not send any money at this stage —an invoice will be sent with the catalogue. No acknowledgment of this order will be made; the catalogues will be distributed as soon as they are available.

MATERIALS HANDLING CONFERENCE

"TO—THRO'—OUT"

In their investigations into materials handling practice in Britain, the Materials Handling Sub-Committee of the Institution have been concerned at the lack of subject matter on handling which is useful to the smaller firm. A great deal of the information and publications available are applicable only to large concerns, and it is one of the primary aims of the Sub-Committee to do what they can to remedy this deficiency.

As a contribution to this end, a one-day conference is being arranged, under the auspices of the Sub-Committee, and will be held at the works of John Wright & Company (Radiation) Limited, Aston, Birmingham, 6, on Saturday, 23rd October, 1954. The theme of the Conference is "TO - THRO' - OUT"—the handling of materials and components *TO* the factory, *THRO'* the factory, and *OUT* of the factory. The Institution is indebted to J. Ivan Yates, Esq., Chairman of the Birmingham Production Centre, Radiation Ltd., for extending the hospitality of the company and full facilities of their offices and works for this important Conference.

Full details of the Conference programme, which will allow time for free discussion and interchange of information, will be published shortly, but members who would like to attend the Conference are advised to make early application, using the form overleaf. Admission will be by programme only, (5/-), which includes copies of all papers to be presented.

There will also be, in conjunction with the Conference, a small Exhibition of photographs illustrating the theme of the Conference. Affiliated firms who are willing to loan photographs for this purpose are invited to contact Mr. C. M. P. Willcox, A.M.I.Prod.E., at P. L. Willcox, Ltd., Standard Works, Tyseley, Birmingham, 11.

To: The Librarian,
The Institution of Production Engineers,
10, Chesterfield Street,
London, W.1.

I shall require.....copy/ies of the catalogue of the Hazleton Memorial Library, at 2/6d per copy, post free.

NAME.....

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PLEASE USE BLOCK LETTERS

To: The Secretary,
The Institution of Production Engineers,
10, Chesterfield Street,
London, W.1.

I wish to attend the Materials Handling Conference which is to be held on Saturday, 23rd October, at the Works of John Wright & Company (Radiation) Limited, Aston, Birmingham, 6. Please send me a copy of the programme.

NAME.....

GRADE.....

ADDRESS.....

NOTE:
No acknowledgment will be made of this reservation. Programmes will be distributed as soon as possible.

PRODUCTION APPOINTMENTS

BULLETIN No. 46

This bulletin is circulated to all members of the Institution monthly as near as possible to the first of the month. Firms or organisations wishing to insert notices in the bulletin should communicate with the Secretary at 10, Chesterfield Street, London, W.1.

The last date for receiving material for insertion in the following month's bulletin is the 20th of each month.
The fee for insertion of particulars regarding each appointment is £3 3s. (up to 100 words), and over 100 words £5 5s. No charge is made to firms affiliated to the Institution, Technical Colleges, Universities and similar organisations.
Advertisers are advised that better response is likely if, in addition to essential qualifications, the following information is given:-
(*a*) Location of appointment; (*b*) Status in the organisation and scope of promotion; (*c*) Salary range and age range.
Advertisers are asked to advise the Institution when vacant appointments are filled. The Institution reserves the right to refuse or withdraw any announcement and also to make any alteration in the wording to ensure conformity with Institution standards.
Members interested in the following appointments should make application in accordance with the terms of notice. No correspondence can be undertaken by the Secretary other than the forwarding of replies to Box Nos.

Production Engineers, with versatile experience in Methods Planning, Press Tools, Jigs and Fixtures and Gauge design, also design of special machines. Confident and competent to control assistant executives and staff. Ability to negotiate with customers at top level. The positions are permanent, and salary commensurate with responsibilities. Applicants must be between age 30-35 and possess previous experience in similar position. Qualified A.M.I.Mech.E. and/or A.M.I. Prod.E. Successful applicant will receive Directorship after first year's service. Locations, Midlands and West of England. Applicants must state details of career and salaries to date. Box No. 834, I.Prod.E., 10, Chesterfield Street, London, W.1.

Chief Time Study Engineer. A well-known Merseyside Engineering Company requires fully qualified Engineer to take complete charge of Time and Motion Study Section. Applicants required to be experienced in modern production methods applicable to heavy and light steel products. Write, giving full details of age, qualifications, experience and salary required, etc., to: Box No. 846, I.Prod.E., 10, Chesterfield Street, London, W.1.

Engineer. Production Engineering Research Association has a vacancy for engineer for technical advisory duties. Age not over 40. Good opportunity for advancement for man with initiative. F.S.S.U. Full details of age, experience, qualifications, salary required, etc., to: Secretary, PERA, Melton Mowbray.

Information Officer. The British Institute of Management invites applications from engineers for appointment as Information Officer (Production Management). University degree or membership of I.Mech.E. or I.Prod.E. desirable. A keen mind, good background, knowledge of production management, experience in industry, and ability to write clearly and concisely are essential. Starting salary £550-£600 per annum. Please write, giving full details, to: Director, Management House, 8, Hill Street, W.1., marking envelope IOP.

Methods Engineering. Applications are invited from first-class men, seeking progressive appointments in production engineering, for positions commanding good salaries on our Methods Engineering staff. Good education, industrial experience and a sound knowledge of light production engineering required, together with personality, imagination and determination to achieve results. Knowledge of time and motion study and standard costing would be an advantage. Write to: The Personnel Manager, The Plessey Company Limited, Vicarage Lane, Ilford, Essex, stating in confidence full particulars and salary required.

A Production Manager (35-45) required by well-established and expanding light engineering company in Midlands, comprising group of factories each specialising in different product and involving mass and batch production. First class practical and technical qualifications essential (at least H.N.C.) with wide managerial experience in light engineering. Excellent promotional opportunities for man of character, energy and ability. Very substantial salary, according to qualifications and experience, with participation in generous superannuation, life assurance and bonus schemes. Applications marked "Attention of Production Director" must give full details of qualifications, positions held and age. Box No. 847, I.Prod.E., 10, Chesterfield Street, London, W.1.

Ratefixer required, to operate within a well-known Group of Companies concerned with light engineering. Good salary commensurate with experience and pensionable position offered. Would be required to operate in either London or Lancashire area. All replies treated with the strictest confidence. Box No. 848, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Controller. A vacancy exists for a Production Controller in a Works situated in south-east England engaged in the manufacture of medium-heavy engineering products and plate work. He will be responsible to the Works Manager for the control and direction of the planning, progress, material control, buying, and stores sections and should possess wide experience in these functions. Some knowledge of work study will be an advantage. Replies giving full chronological details of career, age, present salary, and references, will be treated in the strictest confidence.

Production Engineer. A North London Factory require the services of a Production Engineer with good modern experience to take charge of small Department producing non-ferrous components. Knowledge of pressing, forming, piercing, blanking, essential. Some administrative experience an advantage. Apply giving full particulars of training, qualifications and experience to: Box No. 849, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Engineer (Hydraulics) required. Essential to have thorough experience of production methods, plant etc. in connection with manufacture of precision light hydraulic equipment. Knowledge of high pressure servo-mechanisms an advantage. Desirable to have appropriate degree, or Associate Membership may be considered in certain cases, together with practical shop experience. This is a senior position associated with aircraft instrumentation and control, and preference will be given to applicants with supervisory or administrative experience. Apply with full details, including an indication of salary range, quoting No. 1482 to: Personnel Manager, Sperry Gyroscope Co. Ltd., Great West Road, Brentford, Middlesex.

Production Design Engineer required. Essential to have good instrument design experience, and practical knowledge of modern manufacturing facilities in precision engineering. Knowledge of hydraulics an advantage. Appropriate degree or A.M.I.Mech.E. preferred. Apply with full details, including an indication of salary range, quoting No. 1483 to: Personnel Manager, Sperry Gyroscope Co. Ltd., Great West Road, Brentford, Middlesex.

Works Manager. An aircraft and general engineering firm on the South Coast working on highly skilled machining of mainly the larger prototype details invite applications in writing for the position of Works Manager to take complete charge of production in the shops. Please give details of

experience. Only men who are capable of taking responsibility need apply. Box No. 850, I.Prod.E. 10, Chesterfield Street, London, W.1.

Process Planners required by Sentinel (Shrewsbury) Limited, manufacturers of vehicles, engines and machine tools. Consideration will be given only to men with sound, practical experience in this field of engineering. The posts are superannuated. Apply in confidence to: the Personnel Manager giving full details of technical qualifications, experience, age, etc.

Mechanical Inspector is required by The English Electric Valve Co. Ltd., Chelmsford. Only men with some experience of mass produced and batch produced quantities of press and machine parts should apply for this interesting vacancy. Write with full details of age and experience etc., to: Ref. 1332, Dept. C.P.S., 336/7, Strand, W.C.2.

Manager required for control of specialised engineering work at modern factory in the North-West. Previous experience required in operational planning, tool design, progressing and other functions of factory administration. Familiarity with group and Individual Piecework schemes for large and small batch production. Applications should state age, previous engineering experience and details of technical education, together with an indication of salary required to: Box No. 851, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Engineer. An opening occurs in the Planning Department of a large I.C. Engine Manufacturer in the East Midlands for a Production Engineer capable of undertaking the detailed planning for quantity machining of engine components with special reference to automatics of all kinds. The position will also involve full apprenticeship, O.N.C. and experience in the automobile industry. Please reply stating age, experience (in chronological order) and salary required. All replies treated in confidence. Box No. 852, I.Prod.E., 10, Chesterfield Street, London, W.1.

Manufacturing Engineer required by large Glasgow engineering firm. This is a new and interesting appointment and the main duties will be to ensure that designs are best suited to existing facilities and that new methods are introduced as necessary. Primary importance will be attached to extensive practical experience in heavy plating work and machine shops, though a university degree would be an added advantage. This senior appointment will involve dealing with staff at all levels, and a minimum salary of £1,200 is envisaged. A contributory pension scheme is in operation. Full details of experience should be sent to: Box No. 853, I.Prod.E., 10, Chesterfield Street, London, W.1.

Methods Engineer. Brookhirst Switchgear Limited, Chester, manufacturers of electric control gear, invite applications for the position of Methods Engineer. Applicants must have served an engineering apprenticeship and have had experience, not necessarily in the electrical industry, of modern methods and time study techniques for small sized parts manufacture and assembly. This is a responsible position, offering excellent prospects for early promotion. Age 25-35 years; good starting salary according to age and experience. Apply, giving full particulars of age, education, training and experience and salary required to: Personnel Officer, Brookhirst Switchgear Limited, Chester.

Production Engineer required for factory 12 miles from Glasgow, employing about 400 and specialising in manufacture of light pressings and stampings for the electrical industry. Applicants must have had previous experience in production organisation and supervision, preferably in a similar class of work. Salary £1,250-£1,500. Apply with full details to: Box No. 854, I.Prod.E., 10, Chesterfield, Street, London, W.1.

Works Manager required by light engineering company manufacturing for the motor industry, to develop output in new factory 30 miles north of London, with employment up to 1,000 on flow and batch production. Applicants must have had considerable experience in similar capacity with a wide knowledge of modern machining and assembly methods and be well practised in negotiating with Trade Union Labour. Good salary with excellent prospects for keen and ambitious man. Write for form of application to: Box No. 855, I.Prod.E., 10, Chesterfield Street, London, W.1.

Assistant Production Engineer required by progressive company in Medway towns manufacturing Electro-Mechanical instruments. General Engineering Apprenticeship essential, H.N.C. desirable. Experience modern production techniques, Jig and Tool Design, Planning and Ratefixing. Interesting post for applicant with above experience. Write full details with past salaries to: Box P.B.824, c/o 191, Gresham House, E.C.2.

Senior Jig and Tool Draughtsman required to act as checker in drawing office engaged in the tooling of heavy vehicle components. Permanent and pensionable post for right man. Apply: Transport Equipment (Thornycroft) Limited, Basingstoke, Hants.

Production Engineers. The Igranic Electric Company Ltd., is proposing to engage two young professional electrical or mechanical engineers who will be given special opportunities, to prepare them for executive appointments in works management. Applicants should be under 30 years of age and have completed their National Service and either a Graduate or Student apprenticeship. Good starting salary will be paid and the prospects for advancement are most favourable. Reply giving full particulars of age, education, training and experience to: Works Director, Igranic Electric Co. Ltd., Bedford.

Production Engineering Assistants with experience of batch production assembly of light and medium electromechanical apparatus required. H.N.C. or equivalent desirable. Contributory Pension Scheme. Salary commensurate with qualifications and experience. Apply to: Personnel Superintendent, Westinghouse Brake & Signal Co. Ltd., Chippenham, Wilts.

Production Controller required to take charge of Production and Material Control Department in Company operating on mass production scale in Dundee area. Applicants must have experience of machine loading, scheduling, records, forward planning and progressing. Good appearance, education, alertness and drive essential. Age 25-35, starting salary £700 per annum. State education and experience in chronological order and enclose references if available. Box No. 856, I.Prod.E., 10, Chesterfield Street, London, W.1.

Chief Planning and Production Engineer wanted for modern machine tool factory in Somerset. Qualifications, experience and salary required to: Box No. 857, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Engineer age 25-30 required for appointment on Head Office staff of Textile Machinery Makers Limited. Essential qualifications: Good general apprenticeship and drawing office experience; sound knowledge of modern machine shop methods; jig and tool design; planning and ratefixing for batch production. Foundry and Fabrication experience an advantage. Candidates must have personality and drive and the ability to investigate special assignments relating to production. It is also essential that the candidate should have sufficient experience to work on his own initiative and be able to carry a job through without reference to his superiors. A non-contributory Pension scheme is in operation. Applicants should submit full details of general education, training, subsequent experience and salary expected to: the Secretary, Textile Machinery Makers Limited, Hartford Works, Oldham.

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Assistant Buyer. A.P.V. Company Limited, Engineers, Crawley New Town, Sussex. Vacancy exists for Assistant Buyer. Excellent prospects for promotion. Preference will be given to qualified engineer. Good pension scheme. Salary according to qualifications. Write to: The Managing Director.

Works Manager required with highest engineering qualifications and experience in complete control of large works. Age not over 40. Remuneration £1,400 in first year with substantial rapid promotion. Give full details of posts held and qualifications. Box No. 858, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Engineer required with highest technical qualifications. Age not over 40 years. Remuneration £1,400 in first year with rapid promotion to suitable man. Give fullest details of posts held and qualifications to: Box No. 859, I.Prod.E., 10, Chesterfield Street, London, W.1.

Chief Planning Engineer required to take charge of process planning and tool design in an expanding Company engaged on electronic engineering. Directly responsible to the Chief Mechanical Engineer. Exceptional opportunity exists for an outstanding man with experience of radio or telephone production. University graduate preferred, but technical qualifications are regarded as secondary to ability. House available immediately for successful applicant. Apply: Personnel Officer, Airmec Limited, High Wycombe.

Senior Jig and Tool Designer required. Applicants should have served an apprenticeship, have experience of the design of jigs, fixtures, and press tools for light electrical equipment, and preferably have a H.N.C. Permanent Position. Excellent Pension Scheme in operation. Apply: Personnel Officer, Airmec Limited, High Wycombe.

Process Planning Engineers. A member of a well-known group of companies in the Midlands, manufacturing special components for Gas Turbines, invites applications from competent engineers for several vacancies as Process Planning Engineers. Applicants should have had a first class practical background, ability to think clearly and initiative to enable them to follow successfully a component through its initial production difficulties. The work is interesting and absorbing and will cover Research and Development in addition to Production.

Estimator and Ratefixer. In addition to the above, a vacancy also exists for an Estimator and Ratefixer. An excellent practical background is required with the ability to provide basic data for machining times, enabling initial quotations to be prepared and for the control of subcontract machining. A Bonus Scheme is not yet in operation and successful applicant would have to co-operate with existing time study staff.

Jig and Tool and Mechanical Draughtsmen. Several vacancies also exist for Senior Jig and Tool Draughtsmen and one Senior Mechanical Draughtsman. The applicant for the latter post should be capable of designing and developing special purpose machines and fixtures required to improve the company's manufacturing technique. The factory is a new one and is situated within easy reach of Birmingham, Wolverhampton, Walsall and Sutton Coldfield. Considerable housing development is taking place in the area. All replies will be treated in confidence. Box No. 861, I.Prod.E., 10, Chesterfield Street, London, W.1.

Planning Engineers required by expanding company engaged in the mass production of precision electrical equipment 25 miles west of London. Applicants with good experience in process planning for presses, automatics, capstans and light assembly work preferred. Good prospects of advancement. Write in confidence stating age, experience and salary required to: Box No. 862, I.Prod.E., 10, Chesterfield Street, London, W.1.

Works Manager. A Company of national repute requires Works Manager for factory, East Scotland, employing 900 operatives. Supervisory experience at executive level and first-class knowledge of light engineering mass production essential. Commencing salary £1,500 and housing assistance if required. Pension scheme. Applications in confidence to: Box D.G.172, A. K. Advg., 212a, Shaftesbury Avenue, London, W.C.2.

Experienced Engineer with academic and practical qualifications in production techniques, and product design and development, required for post of Assistant and Understudy to Chief Engineer by manufacturers of motor car accessories, subsidiary of important U.S. Company. Age—preferably 30 - 35, but applicants over this age will be considered subject to qualifications. Applications, in writing, should be addressed to: The Chief Engineer, Trico-Folberth Limited, Great West Road, Brentford, Middlesex.

Work Study. Suitably qualified men with a minimum of 2 years experience in Method Study and Work Measurement are required. Write giving fullest details of experience, qualifications and present salary to: Personnel Officer, Guest Keen & Nettlefolds, (Midlands) Ltd., Box 24, Heath Street, Birmingham, 18.

Manufacturing or Methods Engineers and Product Development Engineers. Progress in manufacturing methods and techniques in connection with heavy rotating electrical machines and Mercury Arc Rectifiers have led to several interesting vacancies in The English Electric Co. Ltd., Stafford, for Manufacturing or Methods Engineers and Product Development Engineers. Applications are invited from engineers working in either of these capacities and from those who have a sound background of practical experience in a manufacturing industry, at least O.N.C. and a desire to enter either of these important branches of engineering. Please write, quoting Ref. 1225B to: Dept. C.P.S., 336/7, Strand, W.C.2.

Plant Draughtsman required for engineering works. Experience on workshop layouts and the application of modern handling methods essential. Good salary and permanent position for a man over 25 years of age, with suitable engineering background. Staff pension scheme. Canteen facilities. Applications, which will be treated in the strictest confidence, should state present position, salary and age, to: The Works Manager, W. H. Allen, Sons & Co., Ltd., Queens Engineering Works, Bedford.

Methods Engineers are required by The English Electric Co. Ltd., Luton, for a rapidly expanding department. Applicants should be fully experienced in the following aspects of prototype and large quantity production:

(a) Manufacture of instruments.
(b) Assembly of Structure.
(c) Assembly of electronic equipment.

These are senior appointments bearing the responsibility for reviewing designs for ease of manufacture, methods planning, estimating and consequent proving of methods on production. Salaries will be commensurate with ability and experience and housing assistance will be available for successful applicants. Those who are interested in this advertisement should write, stating age, qualifications, experience and salary required to Ref. 1343, Dept. C.P.S., 336/7, Strand, W.C.2.

Production Engineer required for modern factory about 14 miles West of Marble Arch. New factory for some 400 people not yet in production, but heavy programme of U.H.F. radio in view. Successful applicant, who must be a first-class man will be responsible for organising and supervising actual production (assembly), planning, and testing, and must have had recent similar responsibilities. Good prospects of advancement. Apply in confidence giving fullest particulars, salary proposed, etc., Box No. 863, I.Prod.E., 10, Chesterfield Street, London, W.1.

Jig and Tool Draughtsmen. Rolls-Royce Oil Engine Division require Jig and Tool Draughtsmen. Candidates must have had previous experience and workshop training. Excellent working conditions. Welfare facilities and pension scheme available. Applications with fullest particulars of experience and qualifications should be sent to the Labour Manager (C), Rolls-Royce Limited, Derby.

Engineer. Production Engineering Research Association has vacancy for an engineer in the Technical Enquiry Section which deals with a wide variety of production problems for member-firms. Good opportunities for advancement for man with initiative. Superannuation under F.S.S.U. Full details of age, experience, qualifications, salary required, etc., to Secretary, PERA, Melton Mowbray.

Chief Engineer, with practical experience in initiating design of precision medium and light engineering products required by well established Company, London area. Experience in the design and production of machine tools and automatic machinery or similar class of engineering desirable. Outstanding opportunity for a really first-class man to obtain progressive post for which the Company are prepared to pay substantial salary. Write in confidence to: the General Manager, giving full details of career. Box No. 864, I.Prod.E., 10, Chesterfield Street, London, W.1.

Draughtsmen, required for Design work. Experience of Capstan Lathes and high class medium weight Mechanical Engineering essential. Education standard to H.N.C. desirable. Write stating experience, age and present salary to: Personnel Manager, G. D. Peters & Co. Ltd., Slough.

Foundry Engineer. An enthusiastic man is required to develop plant and processes for new foundry techniques. The work will involve initial experimentation, development of plant and its use in the foundry. Some metallurgical and engineering knowledge is required together with some experience of production problems. Initially the work will be concerned with the continuous casting of phosphor bronzes. Please reply giving details of experience and salary to: Director of Research, Rubery, Owen & Co. Ltd.

Production Engineers and Process Planning Engineers interested in obtaining appointments with good salary and prospects in the Production Engineering Department of a general engineering company in the London area are invited to send details of their experience and qualifications to: Box No. 865, I.Prod.E., 10, Chesterfield Street, London, W.1. Commencing salary up to £700 p.a.

Assistant Process Planning Engineer required for Precision Engineering Works in West Gloucestershire. Must have had experience on modern tooling methods and wide variety components and assemblies. Pension scheme operating. Write stating age, qualifications and experience to: Box No. 866, I.Prod.E., 10, Chesterfield Street, London, W.1.

Qualified Production Design Engineer required by old established light industrial manufacturing concern. Age about 25/30 years; of strong personality. Excellent prospects for keen man, with practical experience of industrial problems and production methods. Post entails a certain amount of home and foreign travel between kindred factories. Must have had workshop training, and of good education: also possess a degree in mechanical engineering. Salary commensurate with qualifications and experience. Apply giving full details of education, apprenticeship, and experience in chronological order. State present remuneration. Box No. 860, I.Prod.E., 10, Chesterfield Street, London, W.1.

Planning and Estimating Engineer with knowledge of electronics and electronic industry required immediately in rapidly expanding Company situated in Thames Ditton. Duties will include planning, estimating, work study and allied duties. Apply to: Production Manager, Solartron Laboratory Instruments Limited, Queens Road, Thames Ditton, Surrey.

Production Engineer. Carter & Co. Limited, Poole, Dorset, Architectural Potters, require a Production Engineer for their factories in Poole, making glazed wall and floor tiles and employing some 425 operatives. The position calls for a qualified man, preferably not more than about 35 years old, with considerable practical experience of production management. A knowledge of the ceramic industry would be an advantage but is not essential. Applications, which must include fullest details of education, qualifications and experience and which should give some idea of the salary required, should be addressed to the Managing Director.

Work Study and Methods Engineer required with good practical background. Experience in up-to-date techniques of assembly, fabricating, welding and finishing operations. Duties will include time and motion studying, planning of processes and the investigations of existing methods and costs. The appointment is a permanent and pensionable one with a generous salary for an energetic and resourceful type of man. Applications, stating age, experience, etc., to: Secretary, Williams & Williams, Ltd., Reliance Works, Chester.

Production Control Engineer required by a general engineering factory in Glasgow. The successful candidate after adequate training would act as assistant to the Production Controller and eventually take charge of the Department. Essential qualifications are a sound mechanical engineering background and experience in the latest methods of Production Control. The candidate should have a good general education combined with technical training to at least Higher National Standard. Age should be between 25/30 years. Apply in confidence, giving full details of age, experience and present salary to: Box 861, I.Prod.E., 10, Chesterfield Street, London, W.1.

Senior Jig and Tool Draughtsman required for rapidly expanding works in S. Wales producing light pressed steel, moulded plastic and welded assemblies. Good opportunity for first-class man with press tool and some machine tool experience who is able to assist Production Engineer generally. Write in first instance giving full particulars of experience and salary required to: Personnel Manager, The Mettoy Co. Ltd., Queensway, Fforestfach, Swansea.

EDUCATIONAL APPOINTMENTS

Lecturers.
The Work Study School, The College of Aeronautics, Cranfield, Beds.
The Work Study School, The College of Aeronautics, Cranfield, Beds., wishes to make additional appointments to the lecturing staff. Candidates should have sound experience in the application of modern Work Study techniques in industry and, if possible, should have some experience of lecturing on technical subjects. Graduates would be given special consideration since facilities for research are available. In due course, but not immediately, a small house on site will be made available. The salary offered, dependent upon experience and qualifications, would be not less than £1,000 per annum with superannuation under F.S.S.U. Applications, giving age and personal record should be addressed as above (postal address, Cranfield, Bletchley, Bucks.), not later than 15th July, 1954.

Senior Lecturer in Work Study.
Nottingham and District Technical College, Shakespeare Street, Nottingham.
Applications are invited for the post of Senior Lecturer in Work Study, to give practical demonstrations and lectures to industrial executives. Experience in application of Work Study Techniques is essential. Salary scale: (at present) £1,040 x 25—£1,190 per annum. Further particulars and forms of application may be obtained from the Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham, and should be returned to F. Stephenson, Clerk to the Joint Education Committee, not later than 12th July, 1954.

Loughborough College of Technology.
Applications are invited for the new post of Head of the Industrial Engineering Department.

Very wide scope and considerable prospects are offered to a well qualified engineer who has had responsible industrial experience, and is able to teach, at the highest level, some of the Industrial Engineering subjects of Work Study, Production Planning, Production Processing and Control, Industrial Administration, Human Relations.

The salary offered will be determined by the qualifications and experience of the successful applicant and within the scale of £1,490 to £1,640.

Applications should be sent as soon as possible to The Registrar.